EARTHQUAKE RISK PERCEPTION, COMMUNICATION AND MITIGATION STRATEGIES ACROSS EUROPE

Piero Farabollini, Francesca Romana Lugeri, Silvia Mugnano
Editors

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Cover: Norcia, Piazza San Benedetto. On the left, the civic tower of the Town Hall; on the right, the safety intervention of the facade of the Basilica of San Benedetto, heavily damaged as a result of the seismic events that affected central Italy starting from 24 August 2016.

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Preface

Sebastiano D'Amico[1]

This volume aims at collecting some contributions presented in the S41 "Earthquake risk perception, communication and mitigation strategies" session of the 36th General Assembly of the European Seismological Commission, held in Valletta, Malta, of which I had the honor of being Chairperson and Organizer. The ESC mission is to promote the science of Seismology within the scientific community of the European and Mediterranean countries (encompassing the area from the Mid-Atlantic Ridge to the Ural Mountains and from the Arctic Ocean to northern Africa), by promoting research studies, to extend and enhance scientific co-operation and to train young scientists.

Session S41 was very welcome during the 36th ESC General Assembly since it covered issues related to the perception and communication of seismic risk which are certainly worthy of consideration. In fact, every disaster caused by physical and natural phenomena, such as the earthquake, or deriving from human causes, always represents a cross-section of the life of a community, of society and of the affected place, bringing out the latent vulnerabilities that cause a catastrophe, the resources available and the qualities of the pre-existing (sometime complex) relationships between the population and the authorities. Indeed, it is important to consider also the social aspects also because the latter can be strongly related to the several legal aspects with particular regards to the reconstruction phase after a major earthquake as well as to analyze the communication processes during the emergency, to understand the evolution of local governance, to account of the transformations that take place in the daily life of the involved actors. Thus, social approaches can play a key role in disaster studies. In this context, the session "Earthquake risk perception, communication and mitigation strategies", proposed and coordinated by Francesco De Pascale, Francesca Romana Lugeri, Elena Dell'Agnese, Fausto Marincioni, Francesco Muto and Piero Farabollini, had an excellent response with twenty one contributions presented by scholars from various countries: Spain, Romania, Russia, United

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States, Hungary, France, Taiwan, Turkey, Portugal, Armenia, Greece, Bulgaria, Cyprus, Italy. It was an important occasion that offered original and interesting studies and reflections in the field of earthquake perception, resilience and risk communication, the use of new technologies for seismic risk investigations, with the presentation of several case studies with interdisciplinary and integrated approaches. Resilience, as pointed out by Indirli (2019), in this volume, is another important topic which needs to be addressed. Indirli presents an interesting study on the etymology of the word resilience, which in the last years has assumed ever-increasing importance, both in the academic context and in that relating to policy, to the point of being in competition with the concept of sustainability. From a social perspective, resilience can be defined as an interactive and multidirectional social process, consisting of a set of pre-existing response behavior learned during the event itself (Lucini, 2014).

A key role also was also given by the contributions that deal with the recent earthquakes of Central Italy in 2016 tackling the disaster from different perspectives: from the analysis of food management in the disaster (Marincioni et al., 2019) to the study of social resilience in mountain communities (Carone et al., 2019); from the topic of the second home tourism recovery (Mugnano et al., 2019) to the role of communication spread by the media in the context of the earthquakes of Emilia and Amatrice (Cerase, 2019). In addition, there are two contributions in which the Extraordinary Commissioner for post-earthquake reconstruction of Central Italy (Farabollini, 2019; Farabollini et al., 2019) is involved presenting "a provisional alphabet of reconstruction" and an analysis of the seismic sequence of 2016. Three contributions, on the other hand, present different seismic risk mitigation strategies in Turkey (Braucher and Giandomenici 2019; Dindar et al., 2019; Uzun and Oğlakci, 2019). Rodkin and Pisarenko (2019) present an examination of methods of statistical analysis of seismic regime and related damages. Finally, Volterrani (2019) presents and discusses a draft model for the prevention strategies in relation to the risk of disasters through an analysis of the Italian campaign "I don't take risks".

The result is a book that represents an essential point of reference for those interested in disaster studies regarding earthquake risk in Europe.

References

Braucher C. Giandomenici M., 2019, “Risk Mitigation Through Local Building Knowledge: Turkish Van Region Case Study”. In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 84-103.

Carone T., Burattini G., Marincioni F., “Assessing Resilience of Mountain Communities Hit by the Central Italy Earthquakes of 2016”. In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 285-301.

Cerase A., 2019, “Geoscientists’ voice in the media: framing Earth science in the aftermath of Emilia 2012 and Amatrice 2016 seismic crises”. In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 123-144.

Dindar A.A, Tüzün C., Akinci A., 2019, “Urban Seismic Risk Reduction and Mitigation Strategies in Turkey”. In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 19-42.

Farabollini P., 2019, “The 2016 Earthquake in Central Italy. The Alphabet of Reconstruction”. In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 145-171.

Farabollini P., Angelini S., Fazzini M., Lugeri F.R., Scalella G., GeomorphoLab, 2019, “Earthquakes and Society: the 2016 central Italy reverse seismic sequence”. In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 249-266.

Indirli M., 2019, “An historical flight and some open questions towards a pluralistic but holistic view of resilience”. In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 194-248.

Lucini B., *Disaster Resilience from a Sociological Perspective. Exploring Three Italian Earthquakes as Models for Disaster Resilience Planning*, Humanitarian Solutions in the 21st Century, Springer, Cham, 2014.

Marincioni F., Gioia E., Zoppi M., Vittadini E., 2019, "Food management in disasters: the case study of the earthquakes of 24 august 2016 in Central Italy". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 172-192.

Mugnano S., Carnelli F., Zizzari S., 2019, "The recovery strategy of second homeowners and tourists after a disaster: insights from the 2016 central Italy earthquakes". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 267-284.

Pisarenko V., Rodkin M.V., 2019, "A Collection of Statistical Methods for Analysis of the Disaster Damages and the Seismic Regime". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 43-63.

Uzun A., Oğlakci B., 2019, "Turkey's Earthquake History and Institution Based Earthquake Reduction Policies and Strategies". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 64-83.

Volterrani A., 2019, "Communication-Based Prevention Strategies: A Draft Model Proposal". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 105-122.

Introduction

Piero Farabollini[1], *Francesca Romana Lugeri*[2], *Silvia Mugnano*[3]

Risk and disasters are social constructs deriving from an unsustainable human-environment interaction. Earthquake hazard doesn't create damages and destruction; it is our vulnerability and exposure to such processes that creates the conditions of risk. There is nothing natural about an earthquake disaster, yet the common perception is that humans are victims of nature's extreme events. Moreover, the ability of a society to respond to earthquakes does not depend primarily on the emergency conditions created by the impact, but rather on the pre-disaster settings and circumstances.

From the agricultural revolution onwards, humans have tried to free themselves from the control of nature by modeling the territory for their benefit. This, on the one hand, has enabled the social development we enjoy today, yet, on the other, the interaction with natural processes we do not fully understand has created problems of exposure and vulnerability. The consequences went beyond the creation of risk conditions and caused profound changes in environmental cycles contributing to the current geographies of the Anthropocene.

Recent earthquakes, including those in Italy, have unequivocally shown the dominant role of societal vulnerability in creating those disasters. The Mediterranean region, unceasingly affected by strong earthquakes and almost all type of known natural hazards, is very representative of these complex and multi-scale dynamics.

From an examination of the dramatic events that have recently occurred in the central region of Italy, there emerges the need to provide the general public with correct and clear information on the complex scenario characterising this as well as another- country. Experience teaches us that tackling the subject of the prevention of risk and protection from danger (the avoidance of exposure) is very difficult. What is needed is a communicative strategy that informs the public of the characteristics of a territory (understood

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as a natural and cultural environment) and the relative operative dynamics, just as one should understand the anatomy and physiology of one's own body in order to manage and protect it in the best possible way.

Indeed, a disaster is above all a social event (Alexander, 1991; Ligi, 2009; Pelanda, 1981), in which people are actively involved in the process leading to the occurrence of the catastrophe. It is not by chance that the social sciences engaged in the study of disasters in Europe have experienced an important consolidation in recent years; in Italy, especially since the earthquake of L'Aquila onwards, the national scientific production has substantially aligned to the international growth trend. Such vivacity, as Davide Olori (2017) states, does not correspond to a theoretical reconstruction of the proposals, which on the contrary have widened the distances between the different positions, pursuing - mostly - an applied approach. This volume, instead, is intended to be the first attempt of a proposal that aims to bring together different approaches and viewpoints of scholars from different disciplines on the subjects of reduction, mitigation and communication of earthquake risk: physical and social scientists, physicists, engineers and humanists who participated in the S41 session of the 36th Assembly of the European Seismological Commission which took place in Valletta, Malta from 2 to 7 September 2018, coordinated by Elena Dell'Agnese, Francesco De Pascale, Piero Farabollini, Francesca Romana Lugeri, Fausto Marincioni, and Francesco Muto. This session encouraged abstracts discussing the multiple dimensions of earthquake risk reduction, including, but not limiting to, the following research lines: risk communication and social perception; prevention and population preparedness; community-based approach; adaptive capacity; representation of earthquakes in popular culture; new technologies for investigations of hazards and risk; vulnerability reduction; disaster governance. As a result, this volume, has collected several contributions presented during this session to which other interesting proposals of scholars presented after the publication of the Call for Book chapters of the series have been added. Hence, this book is an output of a rigorous review of those proposals and contributions. The volume is divided into three sections:

1) Mitigation Strategies of Seismic Risk Communication;
2) Communication and Prevention Strategies of Seismic Risk.
3) Resilience and Post-Disaster Recovery.

In the first section, "Mitigation Strategies of Seismic Risk Communication", Cüneyt Tüzün, Ahmet Anıl Dindar, Aybige Akıncı (2019) explain one of the most comprehensive and challenging disaster mitigation strategy being applied in Turkey based on the real experience since the 1999 earthquakes.

Mikhail Rodkin and Vladilen Pisarenko (2019) deal with a review of a series of previous publications by authors about the methods of statistical analysis of seismic regime and related damages. The work of Alper Uzun and Burak Oglakci (2019) covers the prevention and risk management studies to be done before an earthquake occurs, focusing on awareness level and risk governance. Chiara Braucher and Mattia Giandomenici (2019) would propose the proactive and participative approach to the Environment Construction at large, including the "direct intervention from settled communities - still persistent but in serious decrease all around the world - as an important strategy for risk mitigation, an alternative to the profit-based narrations of political decisions". In the second section "Communication and Prevention Strategies of Seismic Risk", Volterrani's chapter (2019) presents and discusses a draft model for the prevention of communication in relation to risk of disasters and other types of crisis, starting from the experience of the Italian campaign "I do not risk", and, finally, to risk of radicalization of second young migrant generation. Andrea Cerase's work (2019) considered the media coverage of scientific issues during the Emilia 2012 and Amatrice 2016 seismic crisis by the four most circulating Italian national newspapers within the 31 days following the first earthquake shock, through a comparative analysis. The contribution of Piero Farabollini (2019) aims to illustrate, through a sort of alphabet the activity of the commissioner, the legislative and financial system and the route - with the relative rules to reach the objectives - necessary to give society the due guarantees. The study of Fausto Marincioni, Eleonora Gioia, Mirco Zoppi and Elena Vittadini (2019) investigates, through a questionnaire, food management in the case of the earthquakes of 24 August 2016 in Central Italy, assessing survivors' ability to access food (food security) and the field kitchens practices to ensure hygiene and avoid food-borne disease outbreak (food safety).
In the third section "Resilience and Post-Disaster Recovery", Maurizio Indirli's work (2019) presents an excursus through the ages and a brief (not exhaustive, of course) state-of-the-art regarding "resilience", pointing out some open questions of the current debate among researchers of different disciplines, working in the fields of hazard mitigation, sustainability, risk assessment, heritage preservation, and so on.

Piero Farabollini, Francesca Romana Lugeri and other authors (2019) deal with the case study of the 2016 central Italy, describing the reverse seismic sequence and the geological effects.

The work of Silvia Mugnano, Fabio Carnelli and Sara Zizzari (2019) aims to discuss what needs to be tackled by response and recovery disaster management policies when second homes are involved, by considering also the expectations and intentions of the affected owners with regards to tourists needs included in the redevelopment plans.

Finally, the chapter of Teresa Carone, Giulio Burattini and Fausto Marincioni (2019) aims to clarify the influence of territorial bonds on social resilience of small mountainous communities in the aftermath of the August 24, 2016 central Italy earthquake.

References

Alexander, D., 1991, "Natural Disasters: A Framework for Research and Teaching", *Disasters*, 15(3): 209-226. DOI: 10.1111/j.1467-7717.1991.tb00455.x.

Braucher C. Giandomenici M., 2019, "Risk Mitigation Through Local Building Knowledge: Turkish Van Region Case Study". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 84-103.

Carone T., Burattini G., Marincioni F., "Assessing Resilience of Mountain Communities Hit by the Central Italy Earthquakes of 2016". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 285-301.

Cerase A., 2019, "Geoscientists' voice in the media: framing Earth science in the aftermath of Emilia 2012 and Amatrice 2016 seismic crises". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 123-144.

De Pascale F., Farabollini P., Lugeri F.R. (Eds.), "Comunicare il rischio, il rischio di comunicare", Prisma – Rivista di Economia – Società – Lavoro, 3, 2018.

Dindar A.A, Tüzün C., Akinci A., 2019, "Urban Seismic Risk Reduction and Mitigation Strategies in Turkey". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 19-42.

Farabollini P., 2019, "The 2016 Earthquake in Central Italy. The Alphabet of Reconstruction". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across*

Europe, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 145-171.

Farabollini P., Angelini S., Fazzini M., Lugeri F.R., Scalella G., GeomorphoLab, 2019, "Earthquakes and Society: the 2016 central Italy reverse seismic sequence". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 249-266.

Indirli M., 2019, "An historical flight and some open questions towards a pluralistic but holistic view of resilience". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 194-248.

Ligi, G., 2009, *Antropologia dei disastri*, Laterza, Bari.

Marincioni F., Gioia E., Zoppi M., Vittadini E., 2019, "Food management in disasters: the case study of the earthquakes of 24 august 2016 in Central Italy". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 172-192.

Mugnano S., Carnelli F., Zizzari S., 2019, "The recovery strategy of second homeowners and tourists after a disaster: insights from the 2016 central Italy earthquakes". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 267-284.

Olori, D., 2017, Per una "questione subalterna" dei disastri, in: Mela, A., Mugnano, S., Olori, D. (Eds.), *Territori vulnerabili. Verso una nuova sociologia dei disastri italiana*, Sociologia Urbana e Rurale, FrancoAngeli, Milan, 81-86.

Pelanda, C., 1981, "Disastro e vulnerabilità socio sistemica", *Rassegna italiana di Sociologia*, 4, 507-532.

Pisarenko V., Rodkin M.V., 2019, "A Collection of Statistical Methods for Analysis of the Disaster Damages and the Seismic Regime". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 43-63.

Uzun A., Oğlakci B., 2019, "Turkey's Earthquake History and Institution Based Earthquake Reduction Policies and Strategies". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication* *and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 64-83.

Volterrani A., 2019, "Communication-Based Prevention Strategies: A Draft Model Proposal". In: Farabollini P., Lugeri F.R., Mugnano S. (Eds.), *Earthquake risk perception, communication and mitigation strategies across Europe*, Il Sileno Edizioni, Geographies of the Anthropocene book series, Rende, 2, 2, 105-122.

Section I

Mitigation Strategies of Seismic Risk

1. Urban Seismic Risk Reduction and Mitigation Strategies in Turkey

Ahmet Anıl Dindar[1]*, Cüneyt Tüzün*[2]*, Aybige Akinci*[3]

Abstract

Since the early ages of humankind, safety and security has been a critical issue against the forces of nature. However, history has always proven the power of nature over humankind in certain regions on Earth for centuries. Indeed, this is a never-ending war between Earth and its inhabitants, namely us, human beings. Humankind's organization (cities, roads, lifelines etc.) in the nature has never been perfect within the view of environmental pollution and excessive consumption of the resources. Particularly, the quality of civil engineering design and practice is strongly affected from the social and economic background of the country. The societies in rapid development claim excessive demands in terms of housing and transportation. Such demands may create vulnerable urban areas if the economic and social conditions are not in balance or harmony. Thus, nature should not be blamed as the scapegoat in the regions where disasters claim human and economic losses. In fact, the reason for the losses is nothing else than humankind itself. A rational question arises then about how to overcome human and economic loss due to natural disasters. The idea of determining the most vulnerable items in urban areas and reconstructing with the most reliable equivalents may seem very challenging. Even though the macroeconomic implications are very complex, reconstructing the items in densely populated areas is the most effective mitigation action against disasters in the short term. Having learnt lessons from the major earthquake disasters in the heart of the industry and mostly dense urban areas, Turkish government has drawn a long strategic road map in the risk perception and the disaster mitigation strategy for almost all the community services and the infrastructure. The development of awareness against disasters has become part of formal education at all ages. The National Disaster Management system was reorganized from scratch and

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the capabilities improved by providing additional financial and human resources. All school and hospital buildings in İstanbul were assessed in terms of seismic safety. Those found inadequate were demolished and then reconstructed. In addition, a law on urban renewal of the seismic risk areas was enacted in 2012 allowing the licensed engineering offices to assess the seismic risk of residential buildings at the request of the house owners. If the assessment report is approved by the local municipality, the building is set to demolish within 60 days following the legal notice to the property owners. Disagreeing owners have the right to get the assessment re-evaluated by the independent peer reviewers. In the case of demolition, the house owners are eligible to receive 12 months of rental support from the government. During the time period 2012 to 2019, more than 120 000 buildings were assessed and 74% of them were demolished, the majority of the latter were in İstanbul area where a major earthquake is expected within the following decades. This chapter is intended to explain one of the most comprehensive and challenging disaster mitigation strategies being applied in Turkey based on experience since the 1999 earthquakes.

Keywords: buildings, disasters, mitigation strategies, Turkey, urban seismic risk reduction,

1. Introduction

Because of the real earthquake threat in Turkey, due to the country's geological and tectonic structure characteristics, the need for seismic hazard studies has become progressively more important for engineering applications, mitigation and reduction of earthquake risk particularly after the two recent earthquakes; İzmit-August 17, 1999, M7.4 and Düzce -November 12, 1999, M7.2 (Erdik et al., 1999). According to statistical results, natural disasters in Turkey from 1900 to 2011 are dominated by earthquakes, and earthquakes are a synonym with the concept of disaster in Turkey (Sonmez Saner, T. 2015; Ergunay, 2007). The United Nations Development Program (2004) and the Global Assessment Report on Disaster Risk Reduction (2009) reported that Turkey ranks high among countries according to mortality risk and significant losses of property due to earthquakes. For example, 1939 Erzincan, M7.9 and 1999 İzmit M7.4 earthquakes caused almost 32,000 and 17,000 fatalities and left more than half a million people homeless. Economic losses caused by larger earthquakes have often exceeded $5 billion (US$) and have reached $23 billion and $10 billion for the 1939 Erzincan and 1999 İzmit earthquakes, respectively.

These major earthquakes have also revealed that buildings are quite vulnerable in the country. A majority of the population is living in earthquake-prone areas where there are also the industrial facilities producing 75% of the nation's economic income (e.g. Marmara and western Anatolian region). The rapid migration from rural to urbanized areas since the 1950s in Turkey caused severe circumstances in terms of vulnerability in every aspect of life. Only 25% of the entire population was living in urban areas in 1950, but this ratio reached 75% in 2017. The new residents of the metropolitan cities demanded to a house in very large numbers. Due to the steadily increasing population, with improper land-use planning, inappropriate construction techniques and inadequate infrastructure systems, associated with existing high hazard level, many major cities in Turkey (e.g. İstanbul, Bursa) have become some of the most risky cities in Europe and the Mediterranean region (Ansal et al., 2010).

The constant and persistent risk of being hit by a devastating earthquake has become a crucial social and financial issue for the Turkish government. The earthquakes of 1999 generated a strong national determination in Turkey to devise new and effective methods of tackling disasters. A number of risk assessment studies have been carried out in Turkey both at national and local levels since 1999. These studies that related to settlement level risks are the Earthquake Master Plan of İstanbul (EMPI) imposed by the Metropolitan Municipality of İstanbul and carried out by four universities in 2003 (ITU, METU, BU and Yıldız Tech. Un.). EMPI developed a comprehensive framework for the determination of urban risks and methods of reducing them. One of the important national projects was the İstanbul Seismic Risk Mitigation and Emergency Preparedness (ISMEP) Project initiated by the Turkish Government, financed by a World Bank loan and carried out by the İstanbul Special Provincial Administration (ISMEP, 2010; www.ipkb.gov.tr). Its objective was to transform densely-populated İstanbul (hosting over 14.6 million people is approximately one-fifth of Turkey's population) into a city resilient to a major earthquake by strengthening the emergency management capacity, enhancing emergency preparedness, activating the seismic risk mitigation actions for priority public buildings and the enforcement of Building Codes. However, all those efforts have not been specified in a particular policy or action plan. In 2009 the Disaster and Emergency Management Presidency of Turkey (AFAD) was also established effective emergency management and civil protection issues on a nationwide scale.

As a part of the Declaration of the National Earthquake Strategy Plan for Turkey (NESAP-2023) between 2012 and 2023, the government decided to implement a very strict policy for action through a law called "Transformation of Areas under the Disaster Risks (No: 6306)" legislated in May 2012. This policy calls for the demolition of risky and illegal buildings and the renewal of those based on some rules and procedures. The cost of urban transformation is roughly estimated to be at $500 billion and the timeframe for completion is, ambitiously, 20 years (Güneş, 2015). By now it has been in use almost in every town in Turkey, however, numerous discussions and allegations have made by academic and non-governmental organizations due to the application procedures This paper deals with the rationale of Law No: 6306, its scope, its procedures, and explains the current situation in its application. Having been enforced for 7 years, there have been many lessons learned from the application of the law and its social and economic effect on society.

2. Seismotectonic Setting and Seismic Activity in Turkey

Turkey is located on the Alpine-Himalayan Seismic Belt which is one of the most seismically active regions in the world. Recently, the compiled historical catalog lists or identifies 2247 events for the time period from 2000 BC to 1900 AD with 212 earthquakes with an intensity (I_o) of nine (IX) greater during the last 4000 years (Soysal et al., 1981; Ambraseys 2009; Albini et al., 2013) Figure 1. During the last century and in the instrumental catalog (1900-2012) 203 events are registered with a magnitude of 6.0 and greater in Anatolia and the surrounding region (Kalafat et al., 2011; Kadirioglu et al., 2016; Duman et al., 2018) (Figure 2).

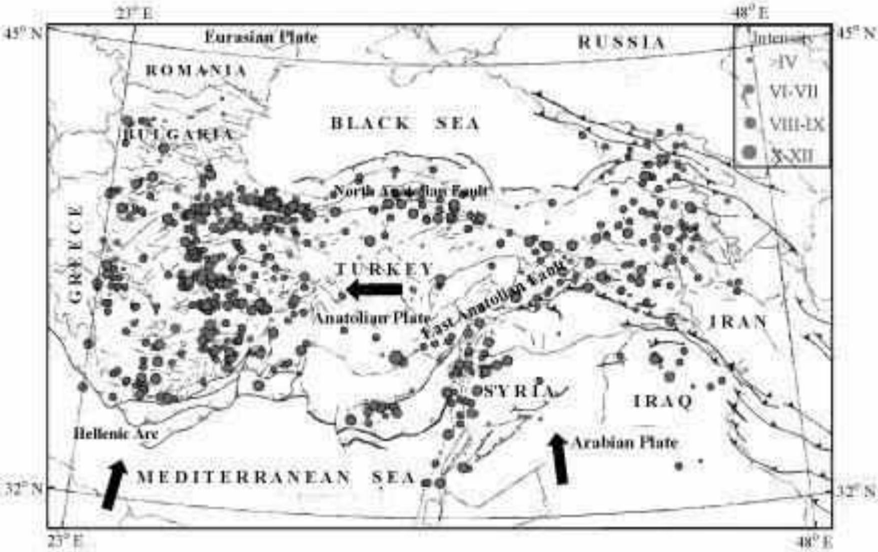


Figure 1 - *Primary, active faults (Emre et al., 2013) and the distribution of historical earthquakes (BC 2000-AD 1900) in Turkey and surrounding areas (Modified from Duman et al., 2018).*

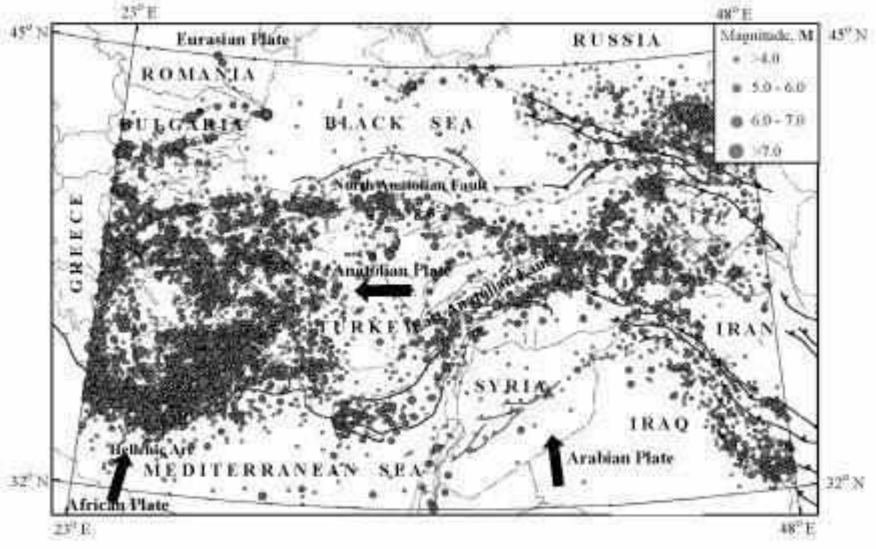


Figure 2 - *Primary, active faults (from Emre et al., 2013) and the instrumental seismicity (1900 -2012) for earthquakes M>4.0 in Turkey and surrounding areas (Modified from Duman et al., 2018).*

Epicenters of the major earthquakes are particularly concentrated in the segment boundaries of the main active faults. Major structures related to strike-slip tectonic regime are the dextral (right strike-slip)North Anatolian and sinisterly (left strike-slip) East Anatolian Fault systems, along with the interim Anatolian plate has been slipped in WSW direction onto easily deductible oceanic lithosphere of the Eastern Mediterranean Sea since the late Early Pliocene (Reilinger et al., 2006, 2010; McKenzie 1978; Le Pichon and Angelier 1979; McClusky et al., 2000; Şengör et al., 1984, 1985; Kocyigit et al., 1999).

The majority of the seismic activity is concentrated along the North Anatolian Fault (NAF) and the East Anatolian Fault (EAF) zones resulting from the westward movement of the Anatolian plate due to the collision of the Arabian and Eurasian plates (Şengör et al., 1984, 1985). The NAF is a large right-lateral strike-slip fault which is continuing roughly 1200 km from the Karliova junction in the east and to the northern Aegean Sea in the west in Turkey (Barka 1992). A sequence of devastating earthquakes occurred on this fault from east to west, starting with the Erzincan earthquake 1939 and followed by seven damaging earthquakes larger than M>7.0; 1942 Erbaa-Niksar, 1943 Tosya, 1944 Bolu-Gerede, 1957 Abant, 1967 Mudurnu and finally 1999 İzmit and Düzce in the 20th century. İstanbul, situated 20 km from the NAFZ in the Marmara Sea, is the largest city in Turkey; the area has experienced high levels of earthquake ground motion since the beginning of human history. Within the past centuries, four earthquakes of M7.6 (1509, 1719, and 1766) and M7.0 (1894) situated in the Marmara Sea have generated intensities up to ten to eleven (X-XI) in the city (Ambraseys, 1971, 2002). Recent studies have shown that the probability of having an earthquake (M≥7.0) close to İstanbul rises from a Poisson estimate of 35% to values of 47% under the time-dependent interaction model during the 30 years starting from 2014 (Murru et al., 2016).

The Eastern North Anatolian fault is also capable of producing large magnitude earthquakes and has experienced a sequence of damaging events including 1949 Karliova M6.8, 1971 and 2003 Bingol M6.9, M6.4, 2010 Elazığ-Karakoçan M6.1 earthquake (Saroglu et al., 1992; Nalbant et al., 2002; Örgülü et al., 2003; Şengör et al., 2005; Bulut et al., 2012). Compression deformation in Eastern Anatolia has resulted in thickening of the crust and includes dominantly reverse faults. The area was exposed to major damaging historical earthquakes in 1111, 1648, 1715, 1881. In 1976, M7.3 an earthquake located near the town of Caldıran, 20 km northeast of Muradiye, caused severe damage in the Van Province killing around 3840 people and leaving around 51,000 homeless (Copley and Jackson 2006; Reillinger et al., 2006). Recently in 2011, M7.1 an earthquake occurred close to the city of Van, killing around 604 people and once again leaving thousands homeless (AFAD, 2011; Akinci and Antonioli, 2012).

Moreover, subduction of the African plate beneath the Aegean plate alongside the Hellenic trench has generated a back-arc N-S directed extensional regime and associated normal faulting in the Western Anatolia (Jackson and McKenzie, 1984; Westaway 1990). In the past fifty-year major earthquakes caused extensive damages and destruction in the zone. For example: 1949 Edremit-Ayvalik M7.0 destroyed nearly 5000 buildings; 1953 Yenice-Gonen M7.4 destroyed 1800 buildings; the 1969 Alasehir M6.9, damaged 3700 buildings and 1970 Gediz M7.3, destroyed 9500 buildings and killed the total 1400 people (Akinci et al., 2013).

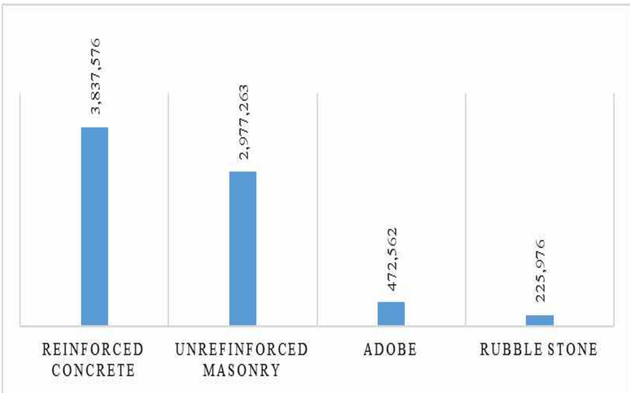
Therefore, an understanding of earthquake structure is an important and unique way to assess and evaluate the earthquake hazard estimation and mitigate losses due to earthquake in Turkey.

3. Building Inventory in Turkey

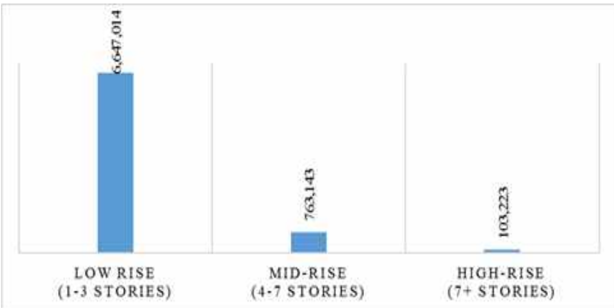
Seismic risk reduction efforts and strategies require gathering detailed information on the building inventory as well as the seismic hazard level in a country. Distribution of the population in a country affects urbanization and eventually the building inventory. The migration of people from rural areas into cities has always created demand in the construction of residential buildings. Depending on the numbers of people, the construction progress and quality can get out of control. In addition to migration, the population growth rate is another factor for the building inventory. Turkey has been a steadily growing country. The population increased from 40 million to 85 million in 40 years period between the 1970s and the 2010s. Thus, the building inventory in Turkey has been affected from both migration from rural areas to cities and the excessive population growth.

The recent building inventory can be divided into two main classifications; construction materials and height (Crowley et al 2012). The construction material is a key parameter in understanding rapid housing. If the demand of housing is huge, it is inevitable that the cheap and widely available materials are preferred. Concrete, particularly reinforced concrete, is a good example of this statement. Combining the cement, limestone, aggregate and water with reinforcing rebar is a relative new technique in building construction.

Compared to the traditional timber and stone masonry buildings those have been around for centuries, reinforced concrete has been used in buildings since the 1940s and its use has growth proportionally since then. From recent research (Demircioğlu, 2009) the total number of buildings in Turkey is 7,513,380 in which 51% of the buildings are made of reinforced concrete, Figure 3a.



(a)



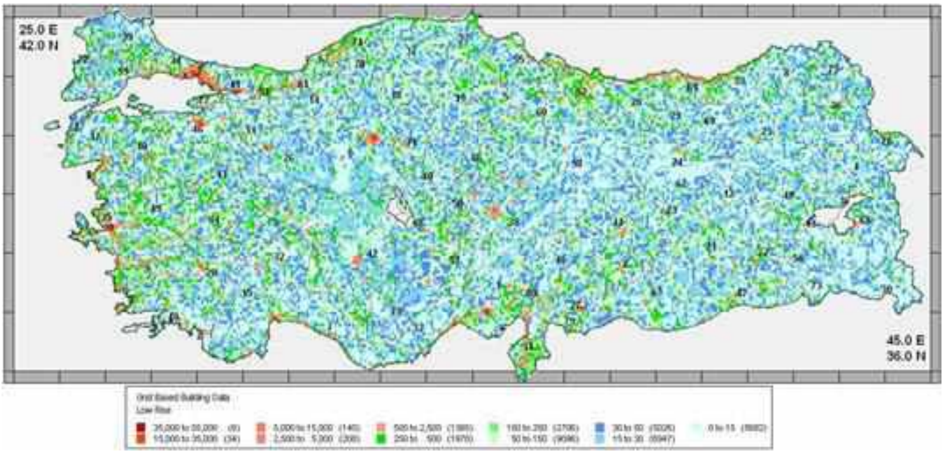
(b)

Figure 3 - *Number of buildings with respect to (a) construction materials and (b) stories (URL1).*

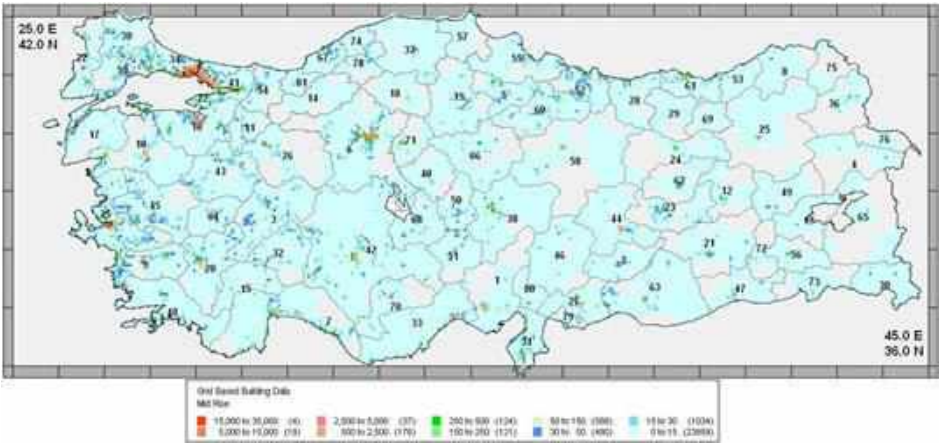
The cultural characteristics of societies influence social life. In countries like Turkey, it is a common convention to own a strong and durable house for a long time. Hence, people invest on the properties that they feel would last for a very long time and would protect them from all kind of natural threats. Based on this convention, reinforced concrete is the commonly preferred building material due to its cost-effective production, widespread availability and cheap labor cost in countries suffering from natural hazards. Moreover, the weight and the toughness of concrete contribute in making people feel psychologically safe and comfortable.

The other classification in describing the building inventory is the building height in terms of number of stories. There is a strong relation between the number of stories of a building and its location. Since the area needed for buildings are expensive in the vicinity of the city centers, the mid-rise buildings are generally preferred rather than low-rise buildings. It is also true that public services such as transportation, electricity and water procurement, sewage etc. is broadly provided to high-populated districts. Thus, the number of stories in relation to the population is a valuable parameter in understanding the structural risk in the country. The distribution of the building height, named in low, mid and high-rise is given in Figure 3b. The number of stories is considered as a realistic value in the definition of the building height.

The number of high-rise buildings is significantly lower than low and mid-rise buildings. Therefore, the spatial distribution of low and mid-rise buildings provides a better understanding in the description of the inventory within the perspective of urban renewal. The building density distribution for all Turkey for low and mid-rise buildings is given in Figure 4a and b, respectively. It is apparent that building density is great in the major cities such as İstanbul, Ankara, İzmir, Antalya, Bursa.



(a)



(b)

Figure 4 - *Distribution of (a) low and (b) mid-rise buildings in Turkey.*

Comparing the building inventory distribution maps (Figure 4a and b) with the seismic hazard map including most active fault lines (Figure 2) distinctly displays the most vulnerable areas in Turkey. Keeping in mind the huge and rapid increase of the building inventory and the seismic hazard, it is evident that major risk mitigation strategies are essential.

4. Urban Renewal Law in Turkey

Starting from the early 1970s, the population in urban areas increased rapidly and consequently serious social and economic arose. The major problem that the big cities faced was the need for accommodation and infrastructure for the new residents. Thus, the construction industry had a huge opportunity to meet the high demand in housing in urban areas all around Turkey, especially in İstanbul. However, the opportunity came with severe problems both in design and construction terms. The main problems can be listed as;

1. Huge demand for reconstruction in a very short time,
2. Lack of modern seismic design codes for professional design engineers,
3. Lack of a peer review process in seismic design of buildings,
4. Inadequate quality control in construction progress,
5. Low quality of workmanship.

In addition to the above-mentioned issues, urban planning strategies and regulations were not compatible with proper seismic risk mitigation principles (Özdemir and Yılmaz, 2011). This situation has lasted for more than three decades resulting with a very huge vulnerable and seismically risky building stock all around Turkey (Green, 2008).

The year of 1999 can be named as the "turning point" in Turkish earthquake history. Two major earthquakes in the north western part of Turkey, 1999 Kocaeli and Düzce earthquakes hit the most urbanized and industrialized cities of İstanbul, Kocaeli, Düzce and Yalova. The results of these earthquakes were catastrophic for Turkey both on a social as well as an economic level. The country suffered a lot from the damages and losses (Durukal and Erdik, 2008). Immediately in the following months, strict measures and actions in the education, construction, legislations and design codes were planned for a resilient society. The planned actions are chronologically listed in the Table 1.

Table 1 - *The major actions in disaster resilience*

Year	*Action*
1999	Marmara Earthquakes (M7.4 on 1999-08-17 and M7.2 on 1999-11-12)
2000	Establishment of Turkish Natural Catastrophe Insurance Pool
2004	Rehabilitation of the public schools in İstanbul
2006	Initiation of the İstanbul Seismic Risk Mitigation and Emergency Preparedness Program
2007	Revision of Turkish Earthquake Code
2008	Rehabilitation of the highway and road bridges
2009	Establishment of Disaster and Emergency Management Directorate
2010	Rehabilitation of the public schools in İzmit
2011	Declaration of the National Earthquake Strategy Plan until 2023
2012	The Law of Transformation of Areas under the Disaster Risks (No: 6306)
2013	Guidelines for the use of seismic isolations in City Hospitals and Seismic Risk Assessment Code for the Buildings
2014	Project for updated Turkish Earthquake Risk Map
2015	Initiation of the National Disaster Response Plan

2016	Detailed revision of the Turkish Seismic Design code – Draft
2016	Revision of the Design Code of the Steel Structures
2018	New Turkish Seismic Hazard Map & revision of Turkish Building Seismic Code
2019	Revision of the Seismic Risk Assessment Code for the Buildings

Among these actions, the Law of Transformation of Areas under the Disaster Risks (No: 6306) has been most effective in terms of practicality and applicability. The law is applied in three phases. It starts with the assessment of the building and ends with re-construction of the new building with reduced bureaucratic procedures. The phases are summarized in Table 2 and visualized in Figure 5.

Table 2 - *Urban Renewal Application in Turkey can be divided into three phases.*

Phases	*Steps*
Phase 1 Assessment of the building	In this phase, relevant official documents of the building are collected, and licensed engineering firms perform engineering inspections and calculations in order to prepare an assessment report that involves seismic safety of the building. As the last step of this phase, the assessment report is delivered to the local authority.
Phase 2 Seismic safety assessment approval of the building by the municipality	Local authority accepts the evaluation report and informs the property registration office. Property owners receive a warrant from the local authority for demolishing or retrofitting options. Once two thirds of the owners agree on the retrofit option, the municipality is informed accordingly. Otherwise, the municipality will have the right to cancel essential services such as electricity, gas and water. Following these measures, the property owners are expected to evacuate the building to be demolished within two months. In case of no evacuation, the owners are forced to leave the property under the control of the police officers.
Phase 3 Demolishing and rebuilding the new property	Demolishing the building is arranged by the owner or his/her representative. Government provides nonrefundable financial support to the rent cost up to 18 months. During this period, the building owners are strictly supposed to either retrofit or rebuild the new building. General practice is to agree with a contractor to get this engineering services.

The steps of the Law of Transformation of Areas under the Disaster Risks are illustrated in Figure 5.

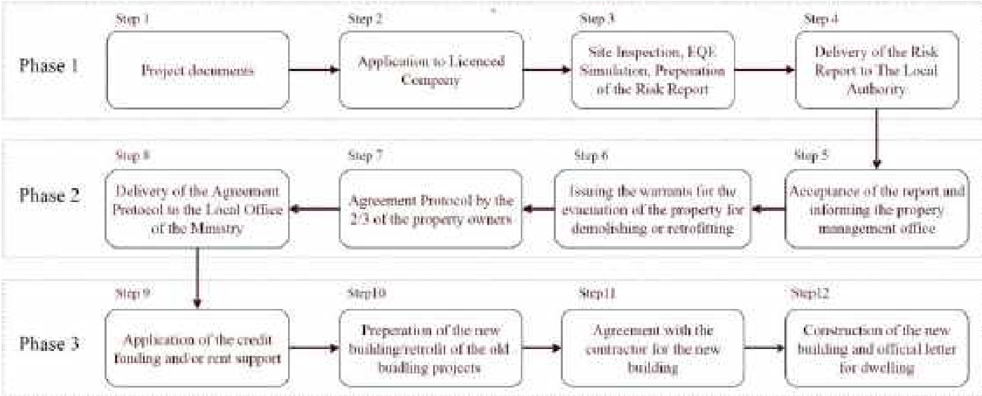


Figure 5 - *Steps of the Urban Renewal Law in Turkey.*

The law legislated by the ministry of Environment and Urbanization delegates the municipalities for the implementation. Initially, the cities of İstanbul, Bursa and İzmir were selected as the areas for preliminary implementation of the law. Since 2012, many cities have benefitted from the law. In early 2019, the ministry requested that all municipalities establish their own urban renewal strategies in their most vulnerable zones. This request was intended to extend the application of the law to almost every part of Turkey rather than major cities to compliment the national mitigation action.

5. Process and Lessons Learned from the Urban Renewal Law in Turkey

As of 2019, a large number of citizens have benefitted from the urban renewal law. Too many lessons learned within that 7 years of application. Based on the official statistics, 174,661 buildings have been assessed by licensed engineering firms. Among these buildings, only 1% was found to be safe in terms of seismic risk. The majority of the assessed buildings are Reinforced Concrete and Masonry type buildings, both 39% (Figure 6).

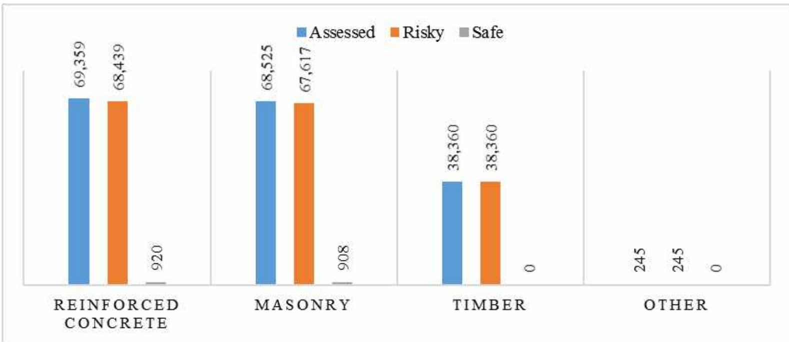


Figure 6 - *Distribution of the construction material in the assessed buildings all over Turkey (URL1).*

Considering the distribution of the assessed buildings in the city, İstanbul is significantly leading with 60%, in the application of the law, Figure 7.

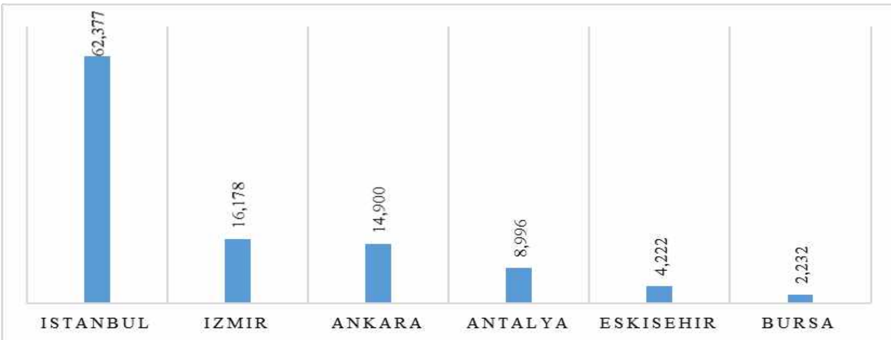
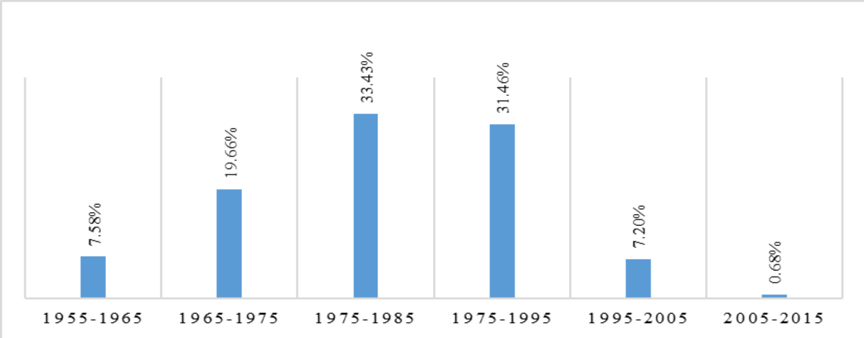


Figure 7 - *Distribution of the assessed buildings in major cities (URL1).*

The age of the assessed building is significant; the most vulnerable buildings were constructed between 1970s to 1990s where the huge demand occurred, Figure 8a.



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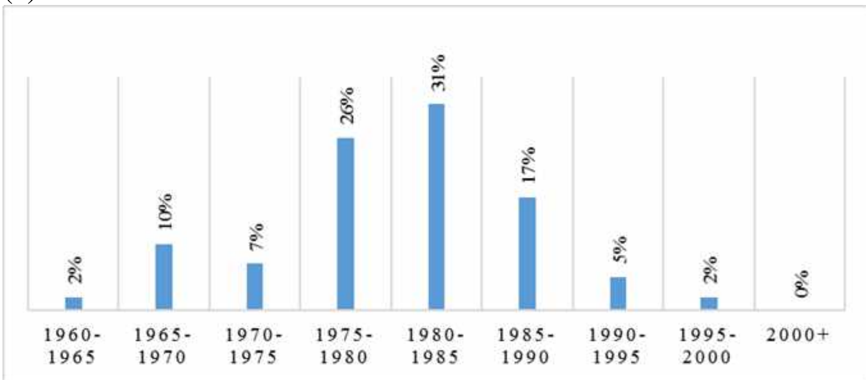

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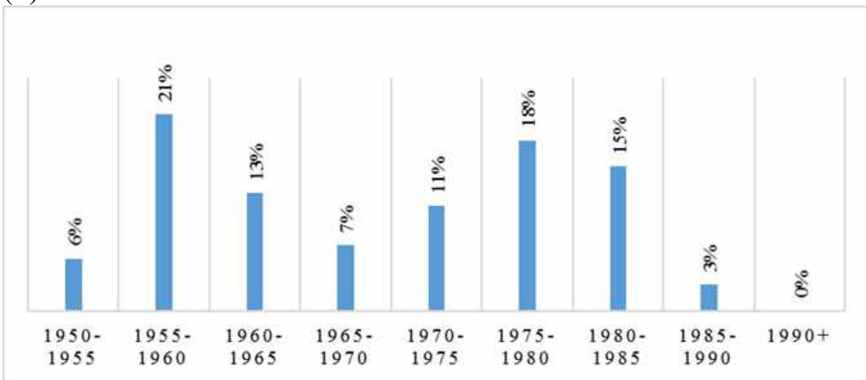

(c)

Figure 8 - *Construction year of the assessed buildings (a) all, (b) Reinforced Concrete, (c) Masonry (URL1).*

The distribution of construction years of the RC buildings given in Figure 8b, has great similarity with the overall distribution in Figure 8a. This indication can be evaluated as the proof of the low quality RC building construction in the period. However, the trend has not been observed in the masonry building type, Figure 8c. The number of the assessed buildings represents 2% of the entire building inventory in Turkey. Whereas, 131,715 buildings, which is 76% of all assessed buildings, have been demolished. The values reveal that more time and effort are needed to reach the ultimate resilient society.

5.1. Examples for good practice

İstanbul is the largest city where the urban renewal cases occurred. Perhaps, the population and the low-quality residential buildings are the main reasons. The Ministry of Environment and Urbanization with the collaboration of municipalities have declared 40 different zones in 16 districts for the preliminary areas for the renewal (Figure 9). The total area of the selected zones is about 11 million m^2. The largest two zones are 1,582,476 m^2 and 1,341,759m^2 on European and Asian sides of the city, respectively.

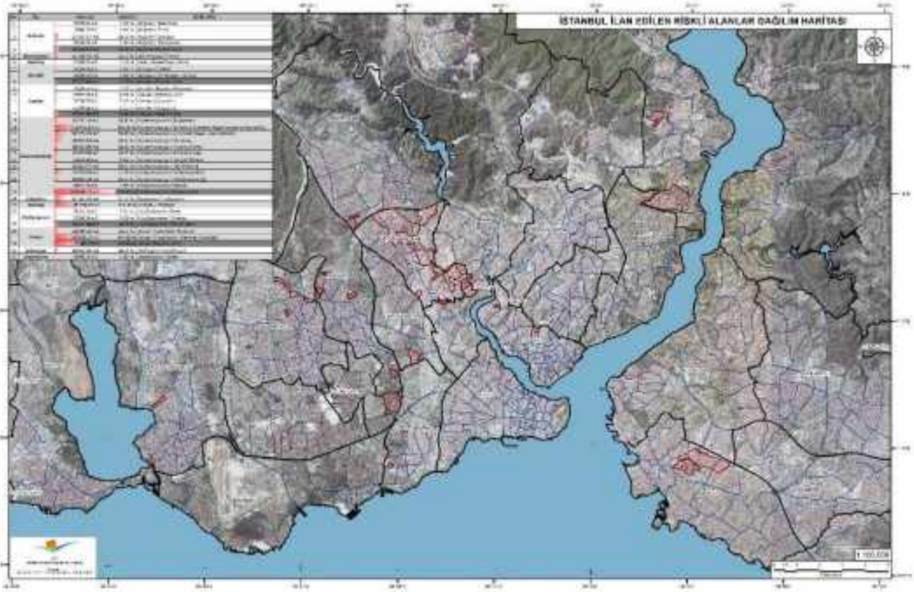

Figure 9 - *Urban Renewal Areas declared in İstanbul (URL2).*

The zone in the Asian side is called the Fikirtepe of Kadıköy district. The building stock in the zone is composed of low-rise buildings that were constructed in the mid 1980s. The strategy followed in Fikirtepe relies on the demolishing the 1,500 small buildings to clear the area, and then the construction of high-rise buildings according to the most recent design codes and engineering practices, Figure 10. The total budget of the renewal was predicted as €4 billion. The huge budget is supposed to be funded by private investors rather than government budgets. The private investors are supposed to prepare the new building design projects and conclude agreements with the property owners. Most of the property owners had legal agreements with the investors either for payment or for ownership of the new buildings.

Figure 10 - *Conceptual view of Fikirtepe district after urban renewal.*

The view of Fikirtepe has significantly changed from a poor environment, Figure 11, to a modern environment, Figure 12.

Figure 11 - *The satellite views of Fikirtepe district in 2007 and 2019 (URL3).*

As of the current situation in 2019, work in Fikirtepe has not been completed, but the progress made has been an example of the Law for the zones, Figure 14.

Figure 12 - *Actual view of Fikirtepe District (as of May 2019)*

5.2. Examples for bad practice

Even though the zones for large-scale renewal were declared, the law has been applied to single buildings. This application has been both positive and negative consequences. The positive side is that the individual buildings in the renewal zones have benefitted from the law for demolishment. Demolishing the detached buildings with seismic risk is a common practice. However, demolishment of a single building in the non-detached buildings does not make a sound in the seismic risk reduction in the urban areas. For example, the building in the middle of Figure 13 demolished within the regulations given in the law. This action is not a real renewal success within the perspective of reducing the risk for an area but only for a single property.

The remaining buildings continue to carry the seismic risk potential for themselves or their surroundings.

Figure 13 - *Bad practice for urban renewal.*

6. Conclusion

As one of the major actions to mitigate the vulnerability of the building stock in Turkey the Turkish Government has issued “The Law of Transformation of Areas under the Disaster Risks (Law No. 6306)”, which came into law in 2012 (published in the Official Gazette of 31.5.2012, no.28309). The scope of the law is to determine the procedures and principles regarding the rehabilitation, clearance, and renovations of areas and buildings at disaster risks in accordance with relevant standards with a view to create healthier and safer living environments in urbanized areas. The number of the expected building renewal is 6.5 million all over Turkey. This is the largest housing project in the world as a part of seismic hazard mitigation.

After seven years of the law, a huge and valuable experience has accumulated through these processes, which could act as a useful example for countries with similar seismic risk. The main points learned from the short history of the urban renewal law can be concluded as:

- Strategically individual assessment preferred to large areas was unsuccessful,
- New constructions are not satisfactory/appealing due to the smaller room size,

- Economic loss of the property owners due to illegally constructed stories,
- Application is more focused on areas where apartment prices are higher than the others,
- Application in the zones like Fikirtepe provided not only seismic safety but also improved infrastructure to the region,
- The law has provided a permanent plan for construction industry causing large economic benefits and increase in real estate values.

In order to provide sustainable urban renewal process for the coming years, possible actions can be recommended as;

- Increasing the economic support (rent for other building during construction) of the building owners by the central government,
- Modifications and update in application process of urban renewal in terms of bureaucracy and regulations,
- Providing benefits for the applicants in terms of land use in suburb/rural areas such as extra stories, larger building base area, exemptions in disaster insurance premiums in the cases of innovative technologies (base isolation, damper, etc.) are used in seismic design or seismic design performance level is taken higher than the seismic code requirement.

The experiences with good and bad examples of economic and engineering approaches applied in the last seven years are invaluable resources for countries suffering from similar hazardous risks for possible adaptations into their own risk mitigation strategies.

References

AFAD, 2011. “Updates, Reports, Damage Statistics – Van Earthquake”, various reports and data updates from 23/10 to 2/11, available from URL:http://www.afad.gov.tr.

Akinci, A., S. D’Amico, L. Malagnini, and A. Mercuri, 2013, “Scaling Earthquake Ground Motions in Western Anatolia, Turkey”, *Physics and Chemistry of the Earth* 63, 124–135.

Albini, P., R.M.W. Musson, A.A. Gomez Capera, M. Locati, A. Rovida, M. Stucchi, and D. Viganò, 2013, *Global Historical Earthquake Archive and Catalogue (1000-1903)*, GEM Technical Report 2013-01 V1.0.0, 202pp., GEM Foundation, Pavia, Italy.

Ambraseys, N. 2002, “The seismic activity of the Marmara Sea region over the last 2000 years”, *Bull. Seismol. Soc. Am.*, 92, 1 –18.

Ambraseys, N. N., 1971, “Value of historical records of earthquakes”, *Nature*, 232, 375–379.

Ambraseys, N. N., 1988, *“Engineering seismology: part I”*, *Earthquake engineering & structural dynamics*, 17(1), 1-50.

Ansal, A., Akinci, A., Cultrera, G., Erdik, M., Pessina, V., Tuzce, G. and Ameri, G., 2010 *“Loss estimation in İstanbul based on deterministic earthquake scenarios in the Marmara Sea region, Turkey”, Soil Dynamics and Earth. Eng.*, 29.4,699-709.

Baris Binici, Ahmet Yakut, Guney Ozcebe, and Atila Erenler, 2015, *“Provisions for the Seismic Risk Evaluation of Existing Reinforced Concrete Buildings in Turkey under the Urban Renewal Law”, Earthquake Spectra*, Vol. 31, No. 3, pp. 1353-1370.

Barka, A. A., 1992, “The North Anatolian fault zone”, *Ann. Tecton.* 6, 164–195.

Bulut, F., M. Bohnhoff, T. Eken, C. Janssen, T. Kılı., and G. Dresen, 2012, “The East Anatolian Fault Zone: Seismotectonic setting and spatiotemporal characteristics of seismicity based on precise earthquake locations”, *J. Geophys. Res.,* doi:10.1029/2011JB008966.

Copley, A., and Jackson, J., 2006, “Active tectonics of the Turkish-Iranian Plateau”, *Tectonics,* 25(6).

Crowley, H., Özcebe, S., Spence, R., Foulser-Piggott, R., Erdik, M., & Alten, K., 2012, *Development of a European building inventory database*. 15th World Conference on Earthquake Engineering, 24-28.

Demircioglu, M. B., 2015, *Earthquake hazard and risk assessment for Turkey*, PhD. thesis. Bogazici University, Turkey.

Duman TY, Çan T, Emre Ö, Kadirioğlu FT, Başarır Baştürk N, Kılıç T, Arslan S, Özalp S, Kartal RF, Kalafat D, Karakaya F, Eroğlu Azak T, Özel NM, Ergintav S, Akkar S, Altınok Y, Tekin S, Cingöz A, Kurt A., 2018, *“Seismotectonic database of Turkey”*, *Bulletin of Earthquake Engineering*, 16(8), 3277-3316.

Durukal, E., & Erdik, M., 2008, “Physical and economic losses sustained by the industry in the 1999 Kocaeli, Turkey earthquake”, *Natural Hazards*, 46(2), 153-178.

Green, R. A., 2008, “Unauthorised development and seismic hazard vulnerability: a study of squatters and engineers in İstanbul, Turkey”, *Disasters*, 32: 358-376.

Gunes, O., 2015, “Turkey's grand challenge: Disaster-proof building inventory within 20 years”, *Case Studies in Construction Materials*, ISSN: 2214-5095, Vol: 2, Page: 18-34.

Jackson J., and D.P. McKenzie, 1984, “Active tectonics of the Alpine Himalayan Belt between western Turkey and Pakistan”, *Geophys. J. R. Astron. Soc.,* 77, 185-246.

Kadirioğlu, F.T., Kartal, R.F., Kılıç, T. et al, 2018, “An improved earthquake catalogue (M ≥ 4.0) for Turkey and its near vicinity (1900–2012)”, *Bull Earthquake Eng* (2018) 16: 3317.

Kalafat D, Güneş Y, Kekovalı K, Kara M, Deniz P, Yılmazer M., 2011, *A revised and extended earthquake catalogue for Turkey since 1900 (M ≥ 4.0),* Boğaziçi University, Kandilli Observatory and Earthquake Research Institute, İstanbul.

Kocyigit A., H. Yusufoglu, E. Bozkurt, 1999, “Evidence from the Gediz graben for episodic two-stage extension in western Turkey”, *Journal of the Geological Society*, London, 156, pp. 605-616

Le Pichon, X., & Angelier, J., 1979, “The Hellenic arc and trench system: a key to the neotectonic evolution of the eastern Mediterranean area”, *Tectonophysics*, 60(1-2), 1-42.

McClusky, S., S. Balassanian, A. Barka, C. Demir, and S. Ergintav, 2000, “Global positioning system constraints on the plate kinematics and dynamics”, *J. Geophys. Res*., 105, 5695–5791.

McKenzie, D., 1978, “Active tectonics of the Alpine—Himalayan belt: the Aegean Sea and surrounding regions”, *Geophysical Journal International*, 55(1), 217-254.

İstanbul Metropolitan Municipality, 2003, *İstanbul Earthquake Master Plan*, İstanbul Metropolitan Municipality, Department of Earthquake Risk Management and Urban Improvement.

Murru, M., Akinci, A., Falcone, G., Pucci, S., Console, R., and Parsons, T. 2016, “M≥ 7 earthquake rupture forecast and time-dependent probability for the Sea of Marmara region, Turkey”, *Journal of Geophysical Research: Solid Earth,* 121(4), 2679-2707.

N. Ambraseys 2009, *Earthquakes in the Mediterranean and Middle East: a multidisciplinary study of seismicity up to 1900*, Cambridge University Press. (ISBN 9780521872928).

Nalbant, S. S., J. McCloskey, S. Steacy, and A. A. Barka, 2002, “Stress accumulation and increased seismic risk in eastern Turkey”, *Earth Planet. Sci. Lett.*, 195, 291–298.

O. Ergunay, 2007, *Turkey's disaster profile, TMMOB Afet Sempozyumu*, Turkish Chamber of Civil Engineers, Ankara, Turkey [in Turkish].

Örgülü, G., M. Aktar, N. Turkelli, E. Sandvol, and M. Barazangi, 2003, "Contribution to the seismotectonics of Eastern Turkey from moderate and small size events", *Geophys. Res. Lett.*, 30(24), 8040.

Ozdemir, O., & Yilmaz, C., 2011, "Factors affecting risk mitigation revisited: the case of earthquake in Turkey", *Journal of Risk Research*, 14(1), 17-46.

Reilinger, R., McClusky, S., Paradissis, D., Ergintav, S., and Vernant, P., 2010, "Geodetic constraints on the tectonic evolution of the Aegean region and strain accumulation along the Hellenic subduction zone", *Tectonophysics*, 488(1-4), 22-30.

Reilinger, R., McClusky, S., Vernant, P., Lawrence, S., Ergintav, S., Cakmak, R., and Nadariya, M., 2006, "GPS constraints on continental deformation in the Africa-Arabia-Eurasia continental collision zone and implications for the dynamics of plate interactions", *Journal of Geophysical Research: Solid Earth*, 111(B5).

Sengör, A. M. C., N. Görür, and F. Şaroğlu, 1985, *Strike-slip faulting and related basin formation in zones of tectonic escape: Turkey as a case study, in Strike-slip Deformation, Basin Formation, and Sedimentation*, Society of Economics Paleontologist and Mineralogist, Special Publication, Vol. 37 (in honor of J. C. Crowell), 227–264.

Sonmez Saner, T., 2015, "Seismic vulnerabilities and risks for urban mitigation planning in Turkey", *Nat Hazards*, 78, 1387.

Soysal H., Sipahioglu S., Kolcak D. and Altinok Y., 1981, *Historical earthquake catalog for Turkey and surrounding region*. Unpublished report No. TBAG-341 submitted to the Scientific and Technical research Council of Turkey (in Turkish).

Şaroğlu, F., Emre, Ö., & Kuşçu, I., 1992, "The east Anatolian fault zone of Turkey", *Annales Tectonicae*, Special Issue-Supplement to Volume VI, 99-125.

Şengör, A. M. C., O. Tüysüz, C. İmren, M. Sakınç, E. Eyidoğan, N. Görür, X. Le Pichon, and C. Rangin, 2005, "The North Anatolian Fault: A new look", *Annu. Rev. Earth Planet. Sci.*, 33, 37–112.

URL1: Ministry of Environment and Urbanization, www.csb.gov.tr, Accessed on January 2019.

URL2: https://İstanbulakdm.csb.gov.tr/İstanbul-da-ilan-edilen-riskli-alanlarin-dagilim-haritasi-i-3750, Accessed on May 2019.

URL3: Google Earth http://earth.google.com, Accessed in May 2019.

Westaway, R., 1990, “Block rotation in western Turkey: 1. Observational evidence”, *J. Geophys. Res.,* 95(B12), 19857– 19884, doi:10.1029/JB095iB12p19857.

2. A Collection of Statistical Methods for Analysis of the Disaster Damages and the Seismic Regime

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Abstract

In this paper, we present a collection of statistical methods addressing heavy tailed distributions. The empirical distributions of damage from natural disasters, both in terms of material losses and fatalities, are often modelled by theoretical distributions with a heavy power-law tail. The distribution of earthquake energy (seismic moments) is another example of such a heavy tailed distribution. The statistical methods that we discuss here allow to perform an analysis of empirical distributions at different levels depending on the amount of available data. We perform a detailed analysis of heavy tailed distribution using the theory of extreme values, and discuss the related examples. The presented methods of analysis of heavy tailed distributions constitute a toolbox, which can be useful in a number of practical applications.

Keywords: disaster related damage; power-law distribution, heavy tailed distribution; theory of extreme values; seismic regime.

Introduction

Most of the damages produced by natural disasters, such as earthquakes or typhoons, are caused by rare and strong events, which release large amounts of energy. Many authors emphasize the universality of the power law distribution when characterizing natural hazards [Turcotte & Malamud, 2004; Newman, 2005; Sornette, 2000; Kijko, 2011; O'Brien et al., 2012; Liu et al., 2014; Kousky, 2014; Smit et al., 2017; Rougier et al.,2018]. Power law distributions are observed for damages caused both by natural and by man-

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made disasters, as well as for energy values and for seismic moments of earthquakes [Sornette, 2000; Clauset et al., 2009]. The main contribution to the damage caused by disasters with a heavy-tailed distribution is due to rare strong events. Therefore, the estimation of magnitude distribution in the uppermost range plays a key role in the problems related to natural disasters hazard assessment and mitigation. The statistical theory of extreme values provides a solid mathematical base for such estimations. In this work, we mainly focus on the problem of seismic risk assessment, since the corresponding data sets are more abundant and well suited for the demonstration of different statistical methods of heavy tailed distribution analysis.

The empirical distribution of damage produced by various types of catastrophes can often be described by the Pareto power-law:

$$F(x) = 1 - (a / x)^{\beta}, \quad x \geq a. \tag{1}$$

Such power-law distribution with the exponent $\beta \leq 1$ has an infinite mathematical expectation $E(X)$:

$$E(X) = \int_a^{\infty} x dF(x) = \beta a^{\beta} \int_a^{\infty} x^{-\beta} dx = \infty.$$

Sample estimates of parameter β in the range $\beta \leq 1$ are readily obtained from empirical data sets. Of course, all real losses and earthquake energies are finite. Thus, the true law of distribution in the range of rare strong events should deviate from the Pareto law (1). The finiteness of a random value can be modelled by a distribution with a maximum possible value [Cosentino et al. 1977; Kijko and Sellevoll, 1989; 1992; Pisarenko et al., 1996; Ward, 1997; Burroughs & Tebbens, 2001; Kijko and Singh, 2011; Vermeulen & Kijko, 2017] or by a distribution with special rapidly decaying factor in the extreme range [Kagan, 1999]. We use below the finite distributions resulting from the extreme value theory: the General Extreme Value distribution (GEV) and the Generalized Pareto Distribution (GPD) with negative form parameter (see below). They naturally appear as the limit distributions for maxima of observed random values [Gumbel, 1958].

This article presents an overview of the results published in a series of works by the authors [Pisarenko & Rodkin 2010; 2014; 2015; 2017; Pisarenko et al., 2014; 2017] and it contains as well several new results.

1. A faster-than-linear growth of cumulative damage with time and its possible incorrect interpretation.

Cumulative damage from natural disasters frequently exhibits a nonlinear (faster than linear) growth with time. This growth is observed for both the number of disasters and for the associated losses (examples are shown in Figs. 1, 2).

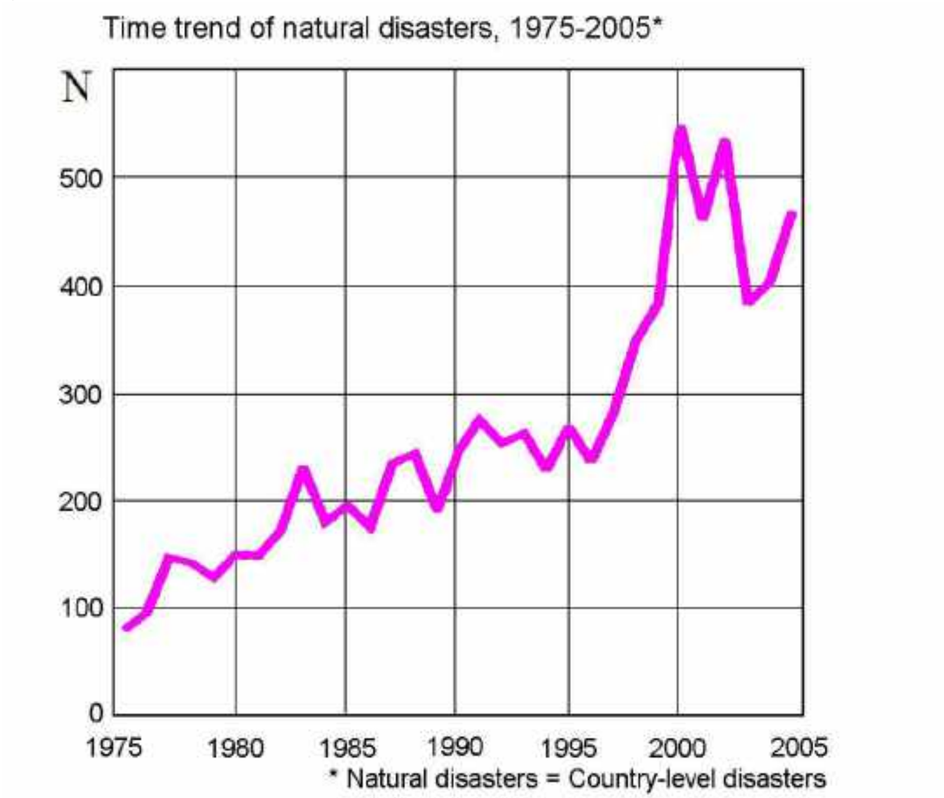

Figure 1 - *The annual number of world natural disasters as a function of time during the period 1975–2005 based on EM–DAT, [Pisarenko & Rodkin, 2010]; the definition of a country-level disaster is given in EM-DAT Glossary and means a disaster that has affected a particular country, if several countries were affected the disaster is indicated several times.*

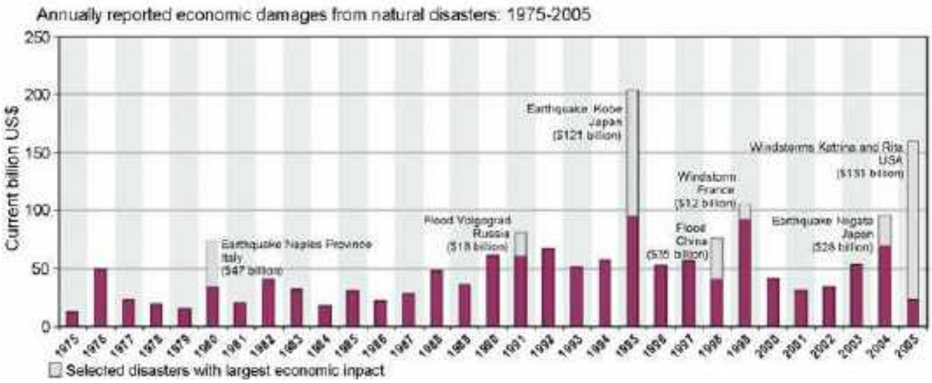

Figure 2 - *Annual losses from natural disasters (including individual most damaging events) during the period 1975–2005 based on EM–DAT, [Pisarenko & Rodkin, 2010].*

Whereas the increase of the number of documented catastrophes may be attributed, at least partly, to the development of registration systems and to a greater availability of the corresponding information, the non-linear growth of cumulative damage requires a separate explanation. Some authors attribute such faster-than-linear growth to such factors as worsening ecological conditions, urbanization, population growth, and climate change [Berz, 1992; Osipov, 1995; 2002; Seneviratne et al., 2012]. However, such growth can as well be observed in a stationary situation, provided the distribution of damage values has a heavy tail [Pisarenko, 1998; Pisarenko and Rodkin, 2010; 2014]. Let us analyze this case in more detail.

As noted above, the empirical distributions of damage produced by different types of natural disasters can be approximated by the Pareto power-law distribution (1). Examples of distribution of damage values from floods, hurricanes and earthquakes in the USA are shown on Fig. 3. The estimates of the exponent β obtained by the maximum likelihood method are less than one, thus we are dealing with heavy tailed distributions.

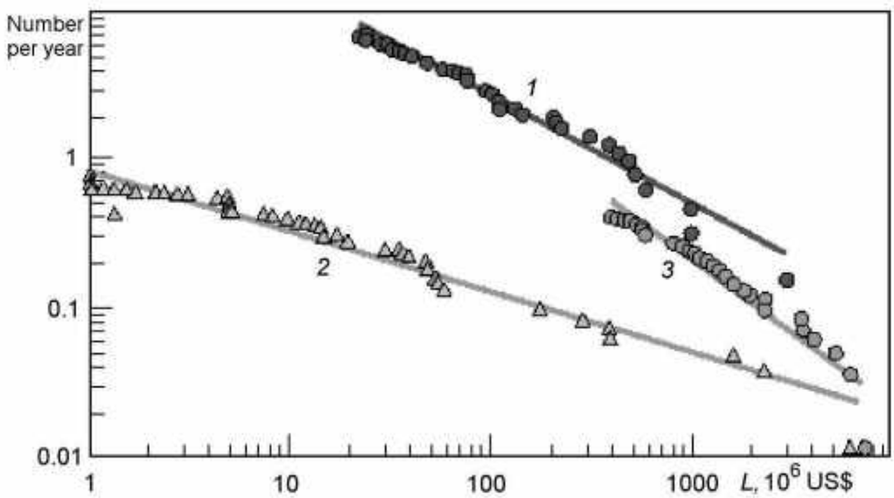

Figure 3 - *Mean numbers N of events per year with economic losses greater than L ($ USA): floods 1986-1992 (1); earthquakes 1900-1989 (2); hurricanes 1986-1989 (3).*

The fitted power-law complementary distributions 1 – F(x) are shown by lines, the values of exponents are: β_n = 0.74 (floods): β_n = 0.41 (earthquakes), and β_n = 0.98 (hurricanes) [Pisarenko & Rodkin, 2010].

The maximum likelihood estimate of parameter β equals

$$\beta_n = n/(\Sigma \ln(x_i/a)), \qquad (2)$$

where the sum is taken over all $x_i \geq a$, i=1, …n.

Now let us assume that the number of events n is a random value obeying the Poisson law

$$Pr\{n=k\}= (\lambda T)^k/ k! \quad ; k = 0,1, 2, 3,...$$

with parameter λT (λ is the intensity of corresponding Poisson process, T is time of observation). Let us consider the median $\mu(T)$ of the largest event that occurred within time interval [$0\ T$]. The median $\mu(T)$ of the maximum event over time T for the Pareto law equals [Pisarenko & Rodkin, 2010]

$$\mu(T) = a\, (\lambda T/\ln(2))^{1/\beta} \ . \qquad (3)$$

Let us denote by $\Sigma(T)$ the sum of damages and by $R(\lambda T, \beta)$ the ratio $\Sigma(T)/\mu(T)$:

$$\Sigma(T) = R(\lambda T, \beta) \times \mu(T). \qquad (4)$$

It can be shown that $R(\lambda T, \beta)$ remains limited as T tends to infinity [Feller, 1966]. This property can be expressed in a different way: for distributions of type (1) with $\beta < 1$, the one strongest event is of the same order as the cumulative sum of all other events. It follows from the above formulas that the mean value $E[\Sigma(T))]$ increases linearly with T for $\beta > 1$ and proportional to $T^{1/\beta}$ for $\beta \leq 1$:

$$E[\Sigma(T))] = C(\beta,T) \cdot T^{\max(1,\, 1/\beta)} ; \quad C(\beta,T) \text{ is limited.} \qquad (5)$$

As it can be seen from (3) - (5), both the single maximum event and the cumulative sum of all the events increase with time in a nonlinear manner, that is proportionally to $T^{1/\beta}$, if $\beta < 1$; and that is true even for a stationary process.

Of course, one should distinguish the statistical effect of a non-linear growth due to a heavy tail, from the effect of a real non-stationarity of the regime of disasters, caused for instance by climate change, by an increased vulnerability of the technological infrastructure to disasters, or by other factors.

As we noted above, a distribution with the exponent $\beta<1$ is not applicable to physical quantities, but for relatively small data sample sizes one can obtain sample estimates $\beta_n <1$ (see Fig.3). This may occur because small data samples with β exceeding unity are hardly distinguishable from samples with β below unity. This effect can be clearly illustrated if we consider the Gutenberg-Richter (G-R) and the truncated G-R distributions, $F_{GR}(x)$ and $F_{TGR}(x)$ respectively. $F_{TGR}(x)$ is bounded by some M_{max} value. One can achieve an arbitrarily small departure $| F_{GR}(x) - F_{TGR}(x) |$ within an arbitrarily wide interval $|x| \leq A$ by choosing a sufficiently large value of M_{max}. This means it is practically impossible to distinguish these two distributions based on small data samples. Thus, one can expect that certain statistical properties of the heavy-tailed distributions cannot be reliably estimated from small or intermediate data samples. It is very difficult to justify the choice of M_{max} for certain types of damages: the associated costs can be extremely high in today's world. But still, one may reasonably assume some kind of saturation of the growth of damages, at least for some types of damages. This saturation effect can reveal itself through a precise shape of the distribution's tail (a bend down of the tail), whereas a non-saturated sample distribution may include a huge event, such as the mega-earthquake Tohoku in Japan (2011, M = 9.08). Such events occur very rarely and can produce effects typical for the heavy-tailed distributions: in particular, they may result in a non-linear growth of total losses over a certain time interval.

2. Description of the bend down of heavy tail distributions – an approximated technique

This section provides a simple method for description of the bend down in the distribution tail, suitable for the cases of small and moderate sample sizes; see [Pisarenko and Rodkin, 2010] for details.

As discussed above, a characteristic feature of the power-law distributions with $\beta < 1$ is a nonlinear initial growth of total damage with time. A similar nonlinear growth is observed for the total released seismic energy (5):

$$E[\Sigma(T))] = C \cdot T^{1/\beta}; \qquad \beta < 1. \tag{6}$$

However, this non-linear growth must slow down with time and eventually become linear with respect to time, which is typical of stationary processes with a finite average value:

$$E[\Sigma(T))] = C \cdot T; \qquad \beta \geq 1. \tag{7}$$

We define the transition time T_{tp} as the time moment when the nonlinear cumulative growth becomes linear. Below we describe how one can evaluate T_{tp}. Let us define the characteristic damage value D_{tp}, with recurrence time T_{tp} corresponding to the transition point. In practice, this transition point can be estimated with a large uncertainty since the available time series of disaster related damage or those of released seismic energy are extremely variable. In order to reduce this uncertainty, we suggest the following bootstrap procedure (see for details [Pisarenko & Rodkin, 2010). We numerically simulate a number of damage curves *S(t),* using a randomly shuffled original data sample (say, 1000 samples). Then for each time *t*, we take the median *MS(t)* of the bootstrap curves *S(t)* :

$$MS(t) = median \langle S(t) \rangle.$$

The median *MS(t)* can be approximated by a simple regression relation

$$lg(MS(t)) = a_o + a_1 \, lg(t) + a_2 \, lg^2(t), \tag{8}$$

where coefficients a_o, a_1, and a_2 are estimated by the standard least squares method.

For stationary time series with a finite average C we obtain

$$MS(t) = Ct, \text{ and } lg(S(t)) = lg(t) + lg(C).$$

Thus,

$$d(lg(MS(t)) / d(lg(t)) = 1. \quad (9)$$

So, we can take this condition for the determination of the transition point T_{tp} exploiting equations (6) - (7) as an assumed behavior of damage curves. The transition point T_{tp} is determined as the smallest t value, for which the equation (6) sill keeps satisfied. Thus,

$$a_1 + 2 \cdot a_2 \, lg(T_{tp}) = 1 \; ; \quad lg(T_{tp}) = (1 - a_1) /(2 \cdot a_2). \quad (10)$$

Using T_{tp} we determine the corresponding damage value D_{tp}:

$$D_{tp} = S(T_{tp}).$$

The value D_{tp} can be regarded as the characteristic damage typical of tail events. The cumulative damage $S(t)$ behaves approximatively linearly with t for $t > T_{tp}$.

The procedure described above is applicable not only to the damage data, but also to the disaster related death tolls and to other data. Results of calculation of T_{tp} and D_{tp} for several available data sets are given in Table 1. It can be seen that the characteristic D_{tp} of victims of natural disasters tends to decrease with time, which can probably be attributed to the global improvement of the technological infrastructures (better quality of civil construction, better hazard mitigation policies etc.).

Table 1 - *Characteristic values T_{tp} and D_{tp} for earthquakes and floods for different world regions and time intervals.*

Disaster type	*Region, country*	*Recur-rence time T_{tp}, years*	*Characte-ristic event, D_{tp}, number of fatalities*	*Maximum event, number of fatalities*	*Data source, data base*
Earth-quakes	Developed countries				Significant earthquakes, NOAA, https://www.ngdc.noaa.gov/nndc/struts/form
	1900-1959	33	95000	110000	
	1960-1999	30	24000	17000	
	Developing countries				
	1900-1959	40	270000	200000	
	1960-1999	60	260000	240000	
Floods	North America and European Union				Em-dat, The International disaster database, https://www.emdat.be
	1950-1980	15	1500	650	
	1980-2005	10	500	200	
	SE and S Asia 1984-2006	20	10000	6000	

3. Description of the bend down of heavy tail distribution – detailed examination

A detailed statistical description of heavy tail distribution~~s~~ can be obtained on the basis of the theory of extreme values. This approach needs, however, substantially larger data samples than the simple method discussed above [Pisarenko, Rodkin, 2010; Pisarenko et al., 2010; Pisarenko, Rodkin, 2014; 2015; 2017 et al.].

There are two limit distributions in the extreme value theory: the Generalized Pareto Distribution (GPD) and the General Extreme Value distribution (GEV). Each of these distributions depends on three parameters and they are closely interconnected (see for details [Pisarenko and Rodkin 2010]). We use below the Generalized Pareto Distribution (GPD). The GPD appears as the limit distribution of scaled excesses over sufficiently high threshold values.

The GPD distribution has three parameters: the form parameter ξ, $-\infty < \xi < +\infty$; the threshold parameter h, $-\infty < h < +\infty$; and the scale parameter s, $0 < s < +\infty$.

The GPD distribution function has the form:

$$GPD_h(\, x \,|\, \xi,\, s) = 1 - [1 + (\xi/s)\cdot(x - h)]^{-1/\xi}, \qquad \xi \neq 0;$$

$$GPD_h(\, x \,|\, 0,\, s) = 1 - exp(-(x - h)/s), \qquad \xi = 0; \tag{11}$$

There is a close connection between GPD and GEV distribution laws. A Poisson flow of events obeying a GPD law is distributed in accordance with the GEV distribution law with the same form parameter ξ. There are simple formulas connecting other parameters of GEV and GPD (see [Embrechts et al. 1997; Pisarenko & Rodkin, 2010]).

Using GPD distribution as limit distribution for a particular data sample involves the estimation of three parameters (11). After this estimation is done, the calculation of any statistical characteristic for the maximum event in any future time interval is a routine procedure. However, the practical use of GPD is often limited by a deficit of available data: our experience shows that a reliable estimation typically requires at least 30 strong events in the uppermost range.

Table 2 presents several estimates of GPD-parameters for a number of disasters (see [Pisarenko & Rodkin, 2014] for details). The value $(-1/\xi - 1)$ characterizes for negative ξ the rate of decay of the density to zero in vicinity of the upper limit bound M_{max} :

$$f(x) \sim 1/(M_{max} - x)^{-1/\xi - 1}, \quad x \to M_{max}\,; \quad -1 < \xi < 0.$$

The faster decay rates of the tail to the zero value (Table 2) are observed for the economic losses produced by floods and hurricanes, whereas the corresponding fatality and the injured/affected distributions have, as a rule, smaller $|\,\xi\,|$-values, which corresponds to a slower decay of the tail.

The maximum M_{max} of the GPD distribution with negative form parameter ξ equals

$$M_{max} = h - s/\xi, \quad \xi < 0. \tag{12}$$

Thus, the lesser $|\,\xi\,|$ the larger M_{max} . Factually it means that in the case of small $|\,\xi\,|$ values, the M_{max} is highly unstable and its estimate is not robust. Instead of using unstable M_{max}, we introduced a more stable estimate that characterizes the uppermost range of the distribution, namely, the quantile of the GPD-distribution. The quantile $Q(q)$ of probability level q for the distribution function $F(x)$ is defined by the relation:

$$F(Q) = q. \qquad (13)$$

Thus, the quantile Q_q is in fact the inverse function with respect to the distribution function $F(x)$. The continuous distribution function and the quantile function are uniquely related. The distribution function is an integral characteristic of random value (in contrast to the local characteristic – the probability density). So, we can consider the quantile as an integral characteristic of the distribution's tail. That is why the quantile gives more stable and robust characterization of the tail than the point estimation M_{max} eq.(12), see discussion [Pisarenko & Rodkin, 2010; 2014]. Besides, one may interpret the quantile Q_q as an upper confidence bound of level q for corresponding random value x:

$$Pr\{ x < Q_q \} = q. \qquad (14)$$

For GPD-distribution the quantile Q_q has the form:

$$Q_q = h + (s/\xi)\cdot[(1-q)^{-\xi} - 1]. \qquad (15)$$

We calculated such quantiles $Q_q(T)$ for maximum event size in future time interval T for a number of disasters [Pisarenko and Rodkin, 2014]. Table 2 presents $Q_q(T)$ with confidence level q=0.95 and time interval 10 years $Q_{0.95}(10)$. The intensity of the seismic flow (number of events per unit time) is designated as λ.

Looking at these estimates, one may conclude that economic losses are strongly influenced by a rapid global development of the technological infrastructure and by the population growth. For that reason, a reliable forecast of such characteristics over long time spans is quite problematic. The quantiles are more robust with respect to such uncertainties.

The last two rows in Table 2 summarize the results of the analysis of annualized data. The aggregation of event sizes over one-year intervals represents in essence a linear filtration (smoothing) of the corresponding time series. That is why the tails of annualized distributions are as a rule less heavy compared to the tails of original distributions. This fact can explain the trend for higher absolute values of the form parameter $|\ \xi\ |$ of annualized distributions in Table 2, compared to the corresponding form parameters for individual events.

Table 2 - Characteristics of disasters and form parameter of fitted GPD-law.

	Lowe threshold m_0, Sample size n, Intensity λ, (1/year)	*Form parameter ξ*	*Maximum observed value*	*Quantile $Q_{0.95}$ (10)*
Seismic moment Mw,CMT catalog, 1976-2012	m_0=6.8 n=324 λ=8.8	-0.16±0.08	9.1	9.1
Earthquake fatalities, Japan, 1900-2011	m_0=3 persons n=44 λ=0.339	-0.26±0.11	142 807 persons	58 thousand persons
Earthquake injured, Japan, 1900-2011	m_0=3 n=99 λ=0.884	-0.37±0.06	103733 persons	75 thousand persons
USA, fatalities from floods, 1995-2011	m_0=3 n=41 λ=1.11	-10^{-9}	35 persons	53 persons
Affected in floods, USA, 1995-2011	m_0=500 n=52 λ=3.06	-0.18±0.11	11 million persons	17 million persons
USA, fatalities from tornadoes, 1953-2012	m_0=20 n=53 λ=0.88	-10^{-9}	1200 persons	1500 persons
Annual economic losses from floods in USA, 1940-2011	m_0=2.5 n=48	-0.35±0.09	51.3, 10^9 \$	46, 10^9 \$
Annual economic losses from hurricanes in USA, 1940-2011	m_0=32 n=64	-0.64±0.05	141, 10^9 \$	123, 10^9 \$

4. A two-branch model for distribution of earthquake magnitudes

As mentioned above, the practical use of GPD approach is limited by a deficit of available data needed for reliable estimation of unknown parameters. The two-branch model that we introduce below, allows us to partially lift this limitation. The magnitude distribution of moderate size earthquakes is well known to obey the normalized Gutenberg-Richter (G-R) distribution law:

$$F(m) = 1 - exp[-b\cdot(m - m_0)]; \qquad m_0 \le m$$

In terms of seismic moment values M_0

$$lg(M_0) = 1.5m + 16.1 \quad \{dine\cdot cm\}$$

This law represents a power-law distribution:

$$Pr\{M_0 < z\} = 1 - C/z^{2b/3\ln(10)}\ ;\ C = const. \tag{16}$$

The exponent in (16) is typically less than unity; therefore, this is a distribution with a heavy tail. We discussed above the physical inconsistence of infinite models with $\beta \leq 1$. The family of GPD-distributions includes infinite distributions with heavy tails when $\xi \geq 0$. But for $\xi < 0$ the GPD-distribution is finite. We propose a model with a distribution that coincides with the Gutenberg-Richter model in the lower and intermediate range, and follows the GPD-distribution with $\xi < 0$ in the large event range [Pisarenko and Rodkin 2020].

These two laws are smoothly attached to each other at some point h, so that the overall distribution function $F(m)$ of the two-branch model is:

$$F(m)= \begin{cases} C_1\{1 - \exp[-b\cdot(m - m_0)]\}; & m_0 \leq m \leq h\ ; \\ C_1\{1 - \exp[-b\cdot(h - m_0)]\} + C_2\{1 - [1 + (\xi/s)\cdot(m - h)]^{-1/\xi}\}; & h \leq m \leq M_{max}\ ,\ \xi < 0. \end{cases} \tag{17}$$

In (17) the first branch corresponds to the G-R law, and the second one is the GPD law with a negative form parameter $\xi < 0$. Here we a priori consider only negative values $\xi < 0$, which corresponds to the finite distribution of magnitudes, in contrast to models sometimes used for the magnitude distribution. One can note that most of the estimates of ξ from real data sets turned to be negative (see Table 2 and [Pisarenko, Rodkin, 2010; 2014]).

Model (17) contains 5 unknown parameters. The threshold h separates 2 branches of the model; b, m_0, s, ξ are the model parameters; C_1, C_2 are constants that depend on the above parameters and should ensure the normalization of the distribution function $F(m)$ and its continuity:

$$C_1 = 1/\{1 + bs\cdot\exp[-b(h-m_0)] - \exp[-b(h-m_0)]\},$$
$$C_2 = 1 - C_1\{1-\exp[-b(h-m_0)]\}. \tag{18}$$

Moreover, we impose that the distribution density function $f(m) = F'(m)$ be continuous at the branches junction point $m=h$. From this condition we get:

$$s = (1+\xi)/b. \tag{19}$$

Finally, we obtain the following two-branch model:

$$F(m) = \begin{cases} C_1\{1 - exp[-b\cdot(m - m_0)]\}; & m_0 \le m \le h; \\ C_3 + C_2\{1 - [1 + \frac{b\xi}{1+\xi}(m - h)]^{-1/\xi}\}; & h \le m \le h - \frac{b\xi}{1+\xi}, \quad -1 < \xi < 0; \end{cases} \qquad (20)$$

$$C_1 = 1/(1+\xi\, exp[-b\cdot(h - m_0)]);$$
$$C_2 = (1 + \xi)\, exp[-b\cdot(h - m_0)] / (1+\xi\, exp[-b\cdot(h - m_0)]);$$
$$C_3 = \{1 - exp[-b\cdot(h - m_0)]\} / (1+\xi\, exp[-b\cdot(h - m_0)]).$$

The meaning of the parameter m_0 is straightforward: it is the lower threshold of the event sizes that satisfy the G-R law. Thus, we are left with three unknown parameters *h, b,* ξ that need to be estimated from data. We estimate these parameters by the maximum likelihood method. The number of unknown parameters (three) is the same as in the case of the GEV or GPD distributions discussed above, but now an additional information about moderate size earthquakes is included in the statistical estimation.

This approach was applied to the data on seismicity of Japan and of the Kuril Islands. We would like to emphasize that the spatial resolution of estimates obtained by using the two-branch model can be higher than that obtained by traditional models, since it provides the parameter estimation based on samples of lesser size.

We illustrate the application of the two-branch model on the following example, where the quantile $Q_q(T)$ of maximum earthquake during the future T years with confidence level q is taken as the main characteristic of the seismic hazard. The quantile $Q_q(T)$ means that in the future T years, the maximum earthquake in the considered region will not exceed $Q_q(T)$ with the probability q. The quantiles $Q_q(T)$ for $T = 50$ years, $q = 0.90$ are presented on Fig. 4.

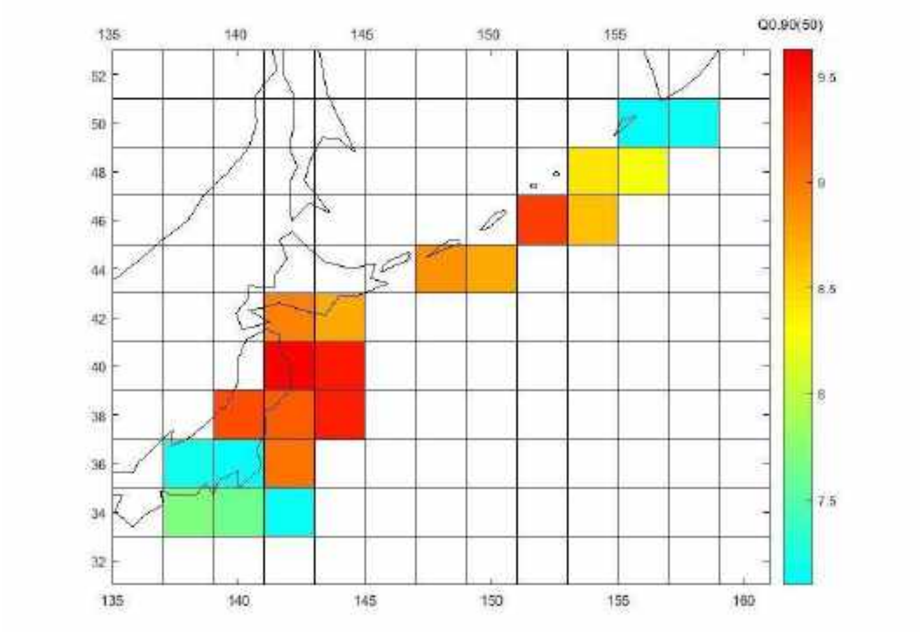

Figure 4 - *The spatial distribution of quantile $Q_{0.9}(50)$ for Japan and the Kuril islands.*

5. Discussion

The power-law heavy tailed distributions have proven to be adequate model for values of damage (such as fatalities) produced by natural disasters, as well as for a number of other characteristics of natural catastrophes. That is true at least for relatively limited time intervals covered by existing catalogs of events. Energy of earthquakes and seismic moments also demonstrate distributions of such kind. The statistical methods described above provide a more or less detailed analysis of the heavy-tailed distributions depending on the amount of available observations. As a first step, the very fact of applicability of the power law distribution can be verified, and the associated exponent β can be estimated. The requirements to the data volume are minimal at this stage. If the exponent for the model power-law distribution is $\beta < 1$ (which occurs quite often in practice), the corresponding distribution has an infinite mathematical expectation. In this case, the standard methods of statistical analysis based on sample mean and sample standard deviation are not applicable, and one can obtained erroneous estimates by using these statistics.

Naturally, all real losses and earthquake energy values are finite. Therefore, the distribution law should deviate from the Pareto law with $\beta<1$ in the range of rare strong events. A more detailed analysis can be performed with the help of models using the concepts of the transition point T_{tp} and the characteristic event size D_{tp} (damage or magnitude). The transition point T_{tp} indicates the time moment when the nonlinear damage growth caused by the effects of the heavy tail becomes linear with respect to time. The characteristic size D_{tp} can be determined through the recurrence time T_{tp}. The data needed for performing such an analysis may include only several events in the extreme range.

Estimates of T_{tp} and D_{tp} for earthquakes and floods related fatalities from event catalogs covering the period 1900-2016 show a decreasing trend for their values with time. One can therefore conclude that the characteristic number of victims resulting from a natural disasters tends to decrease with time, contrary to a wide spread point of view. Similar conclusion can also be made for earthquake death tolls. Observations testify for a certain general decrease with time of fatalities associated with a characteristic natural disaster. These conclusions are in contradiction with some inferences published earlier [Osipov, 1999; 2002].

More detailed analysis of damage distribution can be performed on the basis of the theory of extreme values. However, such an analysis requires a significantly bigger amount of data: practical estimates show that the registered large events should count at least in dozens.

The application of these methods in practice has demonstrated their effectiveness. It can be noted, that in the majority of cases we obtained negative values of the GPD form parameter ξ, which corresponds to a finite distribution with the upper bound M_{max}, see eq.(12):

$$M_{max} = h - s/\xi\,, \quad \xi < 0,\ \ s > 0.$$

Such a result was to be expected: since any real values of fatalities, losses, and energy of disasters are finite, the corresponding distribution law must be finite too. Quite often the obtained estimates of ξ are very close to zero, which gives rise to an instability of the estimation of M_{max}. That explains the uncertainties in the estimation of the maximum regional earthquake magnitude, which in turn leads to the necessity of regular revisions of the seismic zoning maps. The same reason is behind the non-robustness of estimates of the maximum damage values (number of victims) from natural and man-made disasters.

In contrast to non-robust estimates of M_{max}, the quantiles $Q_q(T)$ – the sizes of maximum event for T future years expected with probability q - are robust. The associated damage characteristics T_{tp} and D_{tp} are robust as well.

Practical application of the theory of extreme values encounters limitations due to the lack of strong events in the available observations that are needed for the estimation of GPD- and GEV-parameters. Application of GPD- and GEV- approaches shows that one typically needs at least 30 strong events for a reliable estimation of their parameters. We therefore suggested to use the information contained in moderate size events, and to cover the "strong events" and "moderate events" intervals of the distribution by a common recurrence law. To that end, we introduced the two-branch earthquake size distribution model: the Gutenberg-Richter law is used for the moderate size earthquakes, while the strong earthquakes are modelled by the GPD distribution. Using this approach, we constructed the map of the quantiles $Q_q(\tau)$ of strong earthquakes for Japan and Kuril Islands area which has the spatial resolution approaching that of the seismic zoning maps. Taking into account the similarities of the earthquake size distribution with the distribution of fatalities and disaster related losses, we believe that this approach can also be applied to such data.

6. Conclusion

The heavy tailed distributions are commonly used for modelling of losses from natural disasters (in particular, the number of fatalities). The distribution of seismic moments of earthquakes is also frequently modeled by the power law distribution with a heavy tail. We presented in this paper a collection of statistical methods for studying distributions with heavy tails. These methods allow us to describe the empirical data with the help of statistical models whose degree of detail depends on the amount of the available observations. We demonstrated how the exponent of the approximating power law can be adequately estimated in the case of limited data sets. We also showed how to obtain rough estimates of the transition time T_{tp} from a non-linear to a linear mode of growth of cumulative loss, and the estimates of the characteristic damage size D_{tp}. For larger data samples, the methods of the theory of extreme values can be applied.

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References

Berz, G., 1992, “Munich Re’s list of major disasters in 1990”, *Natural Hazards*, 5, 95-102.

Burroughs, S.M., & Tebbens, S.F., 2001, „Upper-truncated power laws in natural systems“, *Pure and Applied Geophysics*, 158(4), pp. 741–757. DOI: 10.1007/PL00001202.

Clauset, A., Shalizi, C.R. & Newman, M.E., 2009, “Power-law distributions in empirical data”, *SIAM Review*, 51(4), 661–703. DOI: 10.1137/070710111.

Cosentino, P., Ficara, V., & D. Luzio, 1977, “Truncated Exponential Frequency-Magnitude Relationship in the Earthquake Statistics”, *Bull. Seism. Am.* 67, 1615-1623.

Embrechts, P., Kluppelberg, C., Mikosch, T., 1997, *Modelling extremal events,* Berlin-Heidelberg, Springer-Verlag, 645 pp.

Feller W., 1966, *An introduction to probability theory and its applications*, vol II. Wiley, New York.

Gumbel, E.J., 1958, *Statistics of extremes,* Columbia University Press, New York

Kagan, Y.Y., 1999, “Universality of the seismic moment-frequency relation”, *Pure Appl Geophys*., 155. 537–573.

Kijko, A., Sellevoll, M.A., 1989, “Estimation of earthquake hazard parameters from incomplete data files, Part I. Utilization of extreme and complete catalogues with different threshold magnitudes”, *Bull Seism Soc Am* 79:645-654.

Kijko, A., Sellevoll, M.A., 1992, "Estimation of earthquake hazard parameters from incomplete data files, Part II. Incorporation of magnitude heterogeneity", *Bull Seism Soc Am*, 82:120-134.

Kijko, A., 2011, *Seismic hazard. In Encyclopedia of Solid Earth Geophysics* (pp. 1107-1121). Gupta, H.K (Ed.), Springer, Dordrecht.

Kijko, A. & Singh, M., 2011, "Statistical tools for maximum possible earthquake magnitude estimation", *Acta Geophysica*, 59, pp. 674-700. DOI: 10.2478/s11600-011-0012-6.

Kousky, C., 2014, "Informing climate adaptation: A review of the economic costs of natural disasters", *Energy Economics*, 46, pp. 576-592. DOI: 10.1016/j.eneco.2013.09.029.

Liu, Z., Xu, J. & Shi, K., 2014, "Self-organized criticality of climate change", *Theoretical and Applied Climatology*, 115(3-4), pp. 685-691. DOI: 10.1007/s00704-013-0929-6.

Newman, M.E., 2005, "Power laws, Pareto distributions and Zipf's law", *Contemporary Physics*, 46(5), pp. 323-351. DOI: 10.1080/00107510500052444.

O'Brien, K., M. Pelling, A. Patwardhan, S. Hallegatte, A. Maskrey, T. Oki, U. Oswald-Spring, T. Wilbanks, and P.Z., Yanda, 2012, *Toward a sustainable and resilient future. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 437-486.

Osipov VI, 1995, *Natural disasters in the focus of scientists*. Vestnik RAN, 65(6):483–495, in Russian

Osipov VI, 2002, *Natural hazard control.* Vestnik RAN 8:678–686, in Russian.

Pisarenko, V.F., Lyubushin, A.A., Lysenko, V.B., Golubeva, T.V., 1996, "Statistical estimation of seismic hazard parameters: maximum possible magnitude and related parameters", *Bull Seismol Soc Am* 86(3):691–700.

Pisarenko, V.F., 1998, Nonlinear growth of cumulative flood losses with time. Hydrol Process 12, 461-470.

Pisarenko ,V.F., Rodkin, M.V., 2010, *Heavy-tailed distributions in disaster analysis*, Springer, Dordrecht-Heidelberg-London-New York.

Pisarenko, V. F., Sornette, D., Rodkin, M.V., 2010, "Distribution of maximum earthquake magnitudes in future time intervals: application to the seismicity of Japan (1923–2007)", *Earth Planets Space*, 62, 567–578.

Pisarenko, V., Rodkin, M., 2014, *Statistical Analysis of Natural Disasters and Related Losses. Springer Briefs in Earth Sciences*, Springer, Dordrecht-Heidelberg-London-New York, 82 pp.

Pisarenko, V.F., A. Sornette, Sornette, D. & M.V. Rodkin, 2014, "Characterization of the Tail of the Distribution of Earthquake Magnitudes by combining the GEV and GPD descriptions of Extreme Value Theory", *Pure and Applied Geophysics,* 171, 1599-1624. DOI 10.1007/s00024-014-0882-z (http://arXiv.org/abs/0805.1635)

Pisarenko, V.F., M.V. Rodkin, 2015, *The maximum earthquake in future T years: Checking by a real catalog*, Chaos, Solitons & Fractals, 74, 89-98.

Pisarenko, V.F., M.V. Rodkin, "The Estimation of Probability of Extreme Events for Small Samples", *Pure Appl. Geophys*., 2017, 174, 4, 1547–1560, DOI 10.1007/s00024-017-1495-0.

Pisarenko, V.F., M. V. Rodkin, T. A. Rukavishnikova, 2017, "Probability Estimation of Rare Extreme Events in the Case of Small Samples: Technique and Examples of Analysis of Earthquake Catalogs". Izvestiya, *Physics of the Solid Earth,* Vol. 53, No. 6, pp. 805–818.

Pisarenko, V.F., M. V. Rodkin, T. A. Rukavishnikova, 2020, "The stable modification of earthquake recurrence law and perspective of its application in seismic zoning", *Physics of the Solid Earth*, №1, 1-14 (in Russian).

Rougier, J., Sparks, R.S.J., "Cashman, K.V. & Brown, S.K., 2018, The global magnitude–frequency relationship for large explosive volcanic eruptions", *Earth and Planetary Science Letters*, 482, pp. 621-629. DOI: 10.1016/j.epsl.2017.11.015.

Seneviratne, S.I., N. Nicholls, D. Easterling, C.M. Goodess, S. Kanae, J. Kossin, Y. Luo, J. Marengo, K. McInnes, M. Rahimi, M. Reichstein, A. Sorteberg, C. Vera, and X. Zhang, 2012, *Changes in climate extremes and their impacts on the natural physical environment. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 109-230.

Smit, A., Kijko, A. & Stein, A., 2017, "Probabilistic Tsunami Hazard Assessment from Incomplete und Uncertain Historical Catalogues with an

Application to tsunamigenic regions in the Pacific Ocean", *Pure and Applied Geophysics*, Global Tsunami Science: Past and Future, Volume II, 174(8), pp. 3065-3081. DOI: 10.1007/s00024-017-1564-4.

Sornette, D., 2000, *Critical phenomena in natural sciences*, Springer, Berlin, 434

Turcotte, D.L., Malamud B.D., 2004, "Landslides forestfires, and earthquakes: examples of self-organized critical behavior", *Physica A Statist Mech Applications* 340(4):580–589

Vermeulen, P.J. & Kijko, A., 2017, "More statistical tools for maximum possible earthquake magnitude estimation", *Acta Geophysica*, 65(4), pp. 579-587. DOI: 10.1007/s11600-017-0048-3.

Ward, S.N., 1997, "More on Mmax", *Bulletin of the Seismological Society of America*, 87(5), pp. 1199-1208.

3. Turkey's Earthquake History and Institution Based Earthquake Reduction Policies and Strategies

Alper Uzun[1], *Burak Oğlakci*[2]

Abstract

Being one of the most powerful natural disasters, earthquakes are still one of the most serious dangers in the world regardless of whether development levels of countries are high or low. Turkey is a young country and is distinguished as one with high seismic risk due to its tectonic structure. The current risk of an earthquake varies from region to region due to differences in tectonic structures. Turkey, is located in the Alpine Himalayan seismic belt, one of the most active earthquake zones of the earth. The Northern Anatolia, East Anatolia, and Western Anatolian Fault lines are major fault lines in Turkey and constitute the basis of the distribution of earthquake events.

When seismic data is analyzed together with maps of earthquake, it seems like an obvious and important fact of Turkey. At this point, the extent to which the earthquake issue take part in the state and government policies and the level of awareness about the earthquake is the main problem of this research. By considering the relevant institutions, the extent to which the earthquake was included in the natural disaster plans of these institutions was investigated. Regulations issued at various times regarding the aforementioned disaster risk in Turkey are available; however, these laws mostly focus on the post-disaster rehabilitation processes. It can be said that Turkey has not been successful in producing policies and strategies to reduce earthquake risks.

Keywords: Earthquake History, Reduction Policies, DEMP, Turkey.

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1. Introduction

Natural disasters are still one of the most serious dangers in the modern world, despite the advanced technology and the means of civilization. Natural disasters are a social phenomenon as well as a natural phenomenon. Even if earthquakes, which are one of the major natural disasters, cannot be prevented, the tangible and intangible damages they may cause can be minimized. In accomplishing this, individuals and the society have some duties, however, the main responsibility belong to the public institutions and organizations.

Turkey is a country that has often been faced with natural disasters and has suffered several heavy economic and non-economic losses due to its tectonic, seismic, topographic, and climatic structure. From the establishment of the Republic of Turkey to today, earthquakes have been an unchangeable reality with the frequency of occurring, its effect, and results.

Turkey is a young country and is distinguished one with high seismic risk due to its tectonic structure. The current earthquake risk differs from region to region due to its tectonic structure (Özkul and Karaman, 2007). Located in the Alpine-Himalayan belt, Turkey is under the influence of the North Anatolian Fault, the East Anatolian Fault, the West Anatolia Horst-Graben system and many active faults. In 2018, 485 faults and segments were identified in the current active fault map prepared by the Turkey Mineral Research & Exploration General Directorate. 92% of the country, 95% of the population, 98% of the big industrial centers and 93% of the dams are located in the dangerous earthquake zones (Karamanoğlu and Ulay, 2017: 186). This data reveals the fact that Turkey could face the danger of a devastating earthquake at any moment.

Since the establishment of the Republic of Turkey, the country has experienced many large scale and powerful earthquakes. The first one was the Great Erzincan Earthquake. On December 26th 1939, in the eastern part of the North Anatolian Fault Zone, a 7.9 sized earthquake hit Erzincan. This earthquake in Turkey was the largest that had occurred since 1668. According to official figures; 32.968 people lost their lives and 116.720 buildings were destroyed. On August 17th 1999, the Marmara Earthquake whose center was Kocaeli (Gölcük) hit with a magnitude of 7.4 (Disaster and Emergency Management Presidency- DEMP, 2019a). According to official information, 17.480 people were killed, 23.781 people were injured, 285.211 houses and 42.902 workplaces were damaged (TBMM, 2010; DEMP, 2019a). Another major earthquake in the same year (1999) hit Düzce on November 12 and 710 people lost their lives, 2.679 were injured and thousands ended up homeless. Another earthquake with severe consequences for Turkey was the 2011 Van earthquake. This earthquake, which was measured as 7.2, caused destruction due to the existing state of the buildings of the region, 644 people died and 1.966 people were injured (DEMP, 2019a).

On average, Turkey experiences at least one earthquake every year, ranging in magnitude from 5 to 6 (DEMP, 2019b). Earthquakes with devastating effects are causing great damage both to nature and to human life. This natural disaster brings with it a number of sociological and psychological problems, which are difficult to solve. These examples and statistics reveal that Turkey's earthquake history should be well analyzed. In addition, preparedness against earthquakes, institutional policies to reduce the destructive effects of earthquakes and awareness on earthquakes are very important.

The concept of disaster management is valid for all disaster types. The main task of disaster management is to reduce the loss of life and property and to protect the nation from natural or human-factor disasters. In doing so, a comprehensive risk-based disaster and emergency management system is required, including preparedness, protection, response, recovery, harm reduction (Kadıoğlu, 2008). Recently, modern disaster management has emphasized the importance of disaster prevention as well as disaster preparedness. What is done in preparation for the disaster affects the amount of loss of life and property that will occur at the time of the disaster. Disaster management is handled in three stages before, during and after a disaster. It has been observed that the work before the disaster was as important as the interventions during the disaster. Therefore, the distinction between "Crisis Management" and "Risk Management” needs to be carefully addressed and emphasized.

Risk management means investigating the qualities of these negativities and identifying and implementing effective measures that can taken beforehand in order to minimize the harm and negativity that may occur after the disasters. Crisis management covers the activities to be taken quickly in order to determine the problems that occur in the event of a disaster and to make the necessary decisions to overcome the problem with the least damage in the shortest time. Crisis management is unsuccessful where risk management has been neglected. That is, crisis management applied alone is reactive, uncoordinated, aimless, ineffective, ill-timed and it does not give confidence and it is a management style that causes a disaster to turn into a catastrophe (Kadıoğlu, 2008).

In addition to the irreversible consequences of loss of life and property, macroeconomic losses and national wealth losses also pose significant threats to the country's future. Even if an earthquake in the future cannot be prevented, the losses can be reduced to a minimum by safeguard and preparation measures. What is important at this point is the extent of the preparedness of the society as well as how much the managers take the earthquake and other natural disasters into their agendas. To what extent earthquake disaster and awareness level of earthquakes take place in government and state policies constitutes the fundamental problem and focus of this study. The study covers the prevention and risk management studies to be done before an earthquake occurs.

2. Method

In this study, a literature review on the subject was made and then this content was subjected to content analysis. The year 1923, which is the founding year of the Turkish Republic, was chosen as a starting date to reveal Turkey's earthquake history and form maps with data regarding earthquakes. Evidence of earthquakes that took place in Turkey between 1923 and 2018, was taken from various institutions, inventories and databases (Table 1). Related data (EM-DAT, 2019; DEMP, 2019b; ATAG, 2019; USGS, 2019) were entered into a geographic information systems environment. Analysis and visualization of these data have been conducted in a geographical information systems environment. At specified intervals, the institutional structure and legislation focusing on the results and impact of earthquake in Turkey were examined. A comprehensive content analysis have been made on regulations enacted and institutions established after earthquakes. These regulations were published and institutional structures were established in Turkey mostly after major earthquakes. In this direction, policies and strategies for possible earthquakes in Turkey have been revealed. The current status of the legal regulations and institutional structures mentioned and how much they have reflected on the implementation since their publication-establishment are discussed.

Table 1 - *Earthquake Data in Turkey between 1923 and 2018*

Data source (national and international)	*Data*
Emergency Event Database (EM-DAT)	Btw 1923-2018 natural disaster data
Turkey Disaster and Emergency Management Presidency (DEMP) - Turkey Disaster Information Base	Btw 1923-2018 natural disaster data
DEMP - 1900-20xx Earthquake Catalog	Btw 1923-2018 earthquake data
Turkey Active Tectonics Research Group (ATAG) - Geoscience Data Catalog	Btw 1923-2009 earthquake data.
United States Geological Survey (USGS) - Earthquake Hazards Program	Btw 1923-2018 earthquake data.

3. Findings

3.1. Turkey's Earthquake History

The data regarding natural disasters that occurred in Turkey between 1923-2018 were first obtained from an international institution, the Emergency Event Database (EM-DAT). As shown in Table 2, there is data about 109 natural disasters that took place in Turkey in the EM-DAT database at the specified time (Table 2). These disasters are earthquakes, floods, epidemic outbreaks, storms, landslides, high temperatures and fires (natural). The earthquake has been the prominent disaster among them.

Table 2 - *Natural disasters that took place in Turkey, according to the EM-DAT database (1923-2018)*

Earthquakes	Floods	Epidemic Outbreaks	Storms	Landslides	High Temperatures	Fires (Natural)
45	26	7	8	12	7	4

The data presented by DEMP, the only competent authority for disaster and emergency related to Turkey, were examined. When the data provided by the Turkey Disaster Information Base, which is associated with DEMP (Figure 1), there are 7.456 data for natural disasters in Turkey.

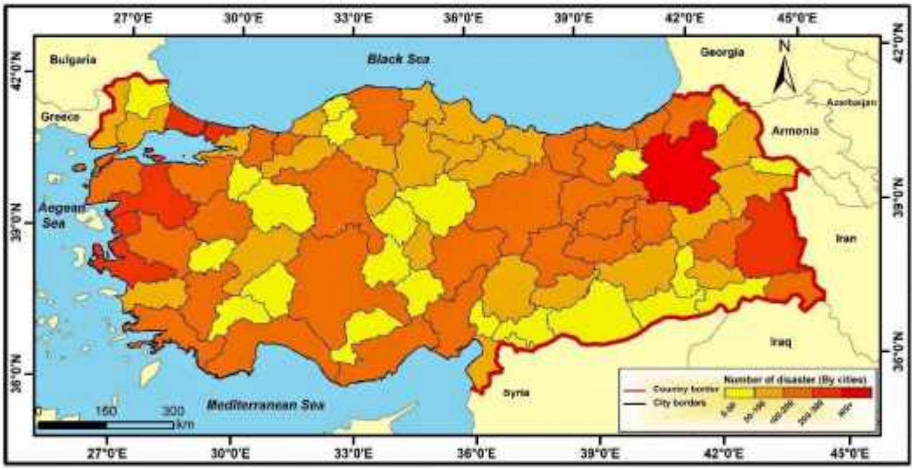

Figure 1 - *Total distribution of natural disasters in Turkey between 1923 and 2018 (by city).*

Among the 7.456 natural disasters in Turkey, earthquakes were the most common disaster. Occurring 1.903 times between the years 1923-2018. The cities where the earthquakes occurred most were İzmir, Balıkesir, Van, and Muğla. In addition, earthquakes are concentrated in areas of densely populated cities in Turkey (Figure 2).

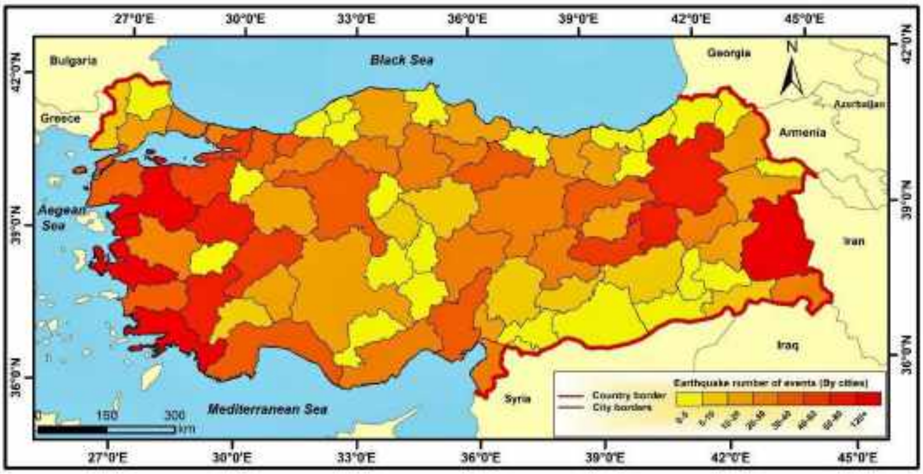

Figure 2 - *Earthquakes between 1923-2018 according to Turkey Disaster Information Base data (by city).*

DEMP's other database offering earthquake data is the 1900-20xx Earthquake Catalog. The catalog has data on earthquakes occurring with over 4.0 magnitude. According to this catalog, 1.543 earthquakes occurred in Turkey at the specified time interval. The map generated by these data presented in dot format with X and Y coordinates is shown in Figure 3.

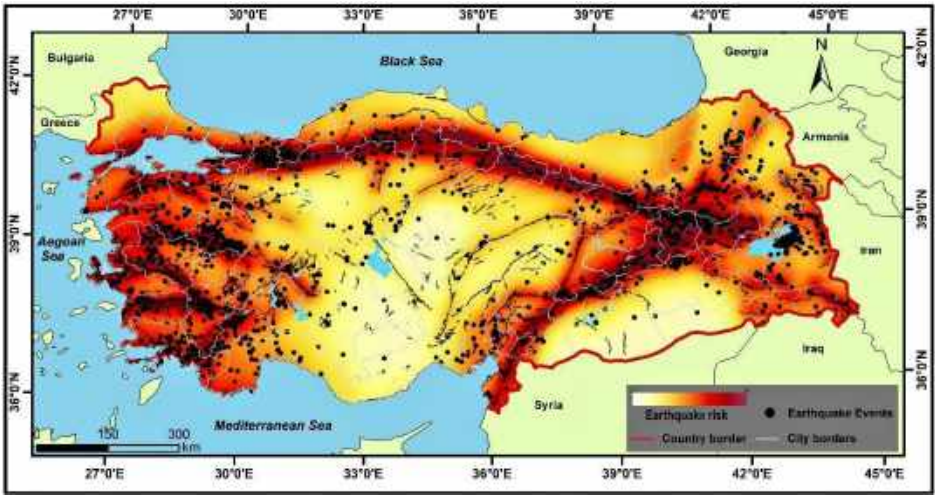

Figure 3 - *Earthquakes between 1923-2018 (By 1900 - 20xx Earthquake Catalog).*

The Active Tectonics Research Group in Turkey has prepared the *Geoscience Data Catalog*. This catalog presents data for Turkey and the surrounding area from 2100 B.C to 2009 A.D. Data covering the period 1923-2009 was taken from this catalog and the map of this data was formed. (Figure 4). There are 3.702 earthquakes in the catalog at the specified time period. These earthquake's data are located in North Anatolia, West and East Anatolia fault lines which are important for Turkey's geological structure.

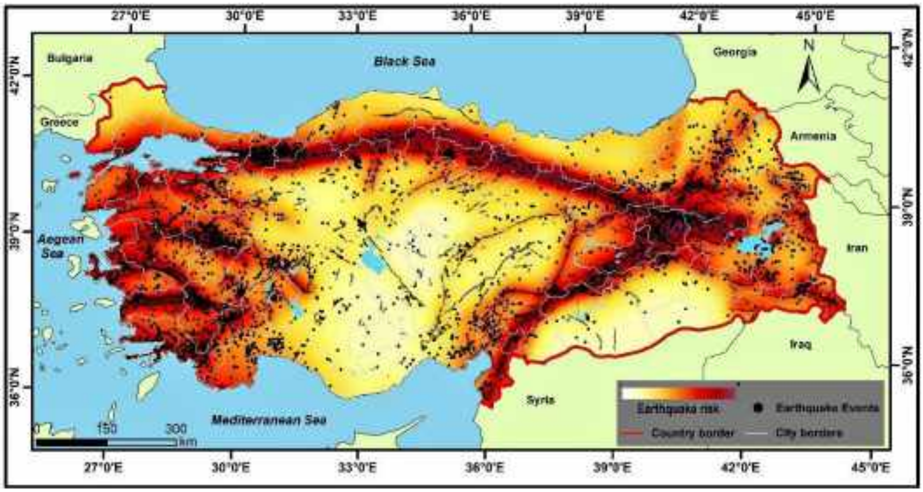

Figure 4 - *Earthquakes between 1923-2009 (By Geosciences data catalog).*

Data for earthquakes in Turkey was also obtained via the United States Geological Survey Earthquake Hazards Program provided by United States Geological Survey (USGS). According to this, the number of earthquakes that occurred at the specified time interval exceeding the magnitude of 4.5 is 835 (Figure 5.)

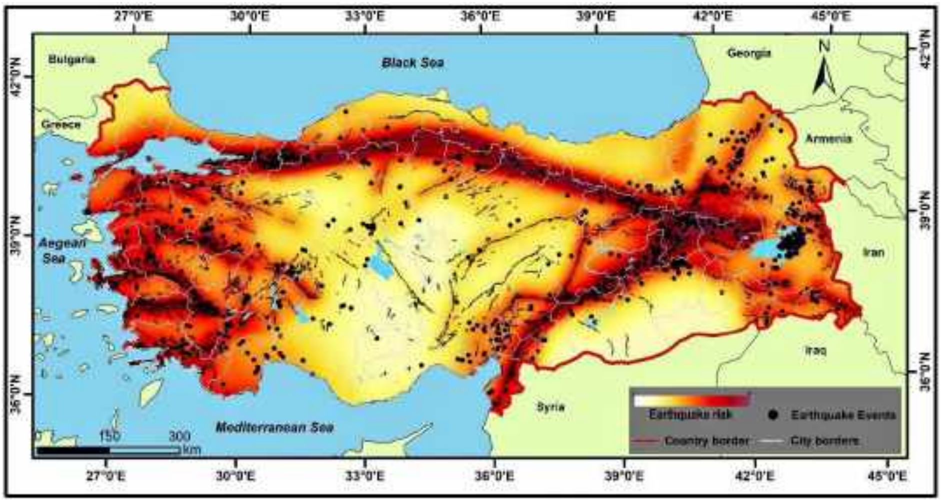

Figure 5 - *Earthquakes between 1923-2018 (by USGS).*

3.2. Legal and Corporate Structure on Earthquake in Turkey

Policies related to natural disasters in Turkey were first started to be prepared after the 1939 great Erzincan earthquake. The Law No. 7269 on "Assistance to be Taken Due to the Measures Against Disasters Regarding Public Life", issued in 1959, aimed to eliminate the legal gap on the subject. In its content, the pre- and post-disaster processes were discussed. The legal regulations regarding disasters continued in 1988 with "Emergency Regulation on Disaster Relief Organizations and Planning Principles" which was issued in order to ensure the fastest access to the disaster area and provide the most effective intervention.

In Turkey the Marmara Earthquake (August 17th 1999) is seen as a milestone in the field of disaster management and coordination. This earthquake, which caused great loss of lives and extensive damage, put forward the obligation of revising disaster management in Turkey. To deal with disasters, the General Directorate of Civil Defence was established under the Ministry of Interior and the General Directorate of Disaster Affairs was established under the Ministry of Public Works and Settlement, and finally the Turkey Prime Ministry Emergency Management General Directorate was established. In 2009 law number 5902, the Disaster and Emergency Management Presidency affiliated to the Prime Ministry was established and the authorities and responsibilities were gathered under one roof.

3.2.1 Compulsory Earthquake Insurance and Turkish Natural Catastrophe Insurance Pool (TCIP)

After the Marmara Earthquake on August 17th 1999, the supposedly-changed perception of the state on natural disasters and earthquakes also affected the development of insurance activities in this context. On November 25th 1999, the Decree Law No. 587 for, Compulsory Earthquake Insurance was enacted.

With the Decree Law No. 587, it became mandatory for house owners to have earthquake insurance and therefore TCIP which is a public legal entity was established to provide this insurance. In accordance with this Decree, the state aims to transfer some of its obligations to the insurance system in order to meet the losses that may occur after a disaster. Following the establishment period within 9 months, TCIP started to offer collaterals as of 27 September 2000 (Şahin and Pehlivan, 2007). In addition, the Decree-Law on

Compulsory Earthquake Insurance in 2012 was abolished with the Law on Disaster Insurance (Law No. 6305 Decree, 2012). TCIP policies in effect in Turkey is currently 9 million, and the insurance rate is 51% (Table 3). Total compensation payments of all years amounts to 187.245.120 TL and the total number of damages paid is 24.430 (TCIP, 2019). It shows a high proportion of insured homes in areas where both the population and earthquake risk are high (Table 3).

Table 3 - *TCIP Current insurance policy* (By Region and Province, 2019)

Geographical regions of Turkey	*Number of dwellings*	*Number of insured housing*	*Policy distribution (%)*	*Insurance rate (%)*
Marmara	6.014.550	3.682.014	40,90	61,20
Central Anatolia	3.332.500	1.588.595	17,60	47,70
Aegean	2.616.350	1.350.825	15,00	51,60
Mediterranean	2.236.030	993.244	11,00	44,40
Black Sea	1.693.780	733.416	8,10	43,30
Southeastern	991.460	363.364	4,00	36,60
Eastern Anatolia	777.020	294.180	3,30	37,90
Total	17.661.690	9.005.638	%100	%51,00

3.2.2. 2004 Earthquake Council of Turkey

An Earthquake Council was held by the Ministry of Public Works and Settlement between September 29th 2004 and October 1st 2004. This has created a platform with wide participation in the Council. The Council was convened with the participation of representatives of various public institutions and organizations, universities, professional chambers, non-governmental organizations and the private sector. The purpose of the meeting is to discuss what should be done about the earthquake and to determine the measures and decisions to be developed for implementation. 354 members of the Council were invited to the Earthquake Council and they discussed the following: Institutional Structuring, Legislation, Disaster Information System, Investigation of Existing Structures and Building Inspection, Construction Materials, Supply of Resources and Insurance Reports of Educational Commissions (Ministry of Public Works and Settlement, 2004).

3.2.3. Regulation on Structures to be built in Earthquake Regions (Earthquake Regulation)

The purpose of this regulation published in 2007 is to take the earthquake zones identified and announced in accordance with Article 2 of the Law No. 7269 in 1959, into account. It covers all buildings that will be re-built, changed and enlarged in these regions. In addition it determined the rules and minimum conditions for the evaluation and strengthening of earthquake-resistant design and construction of all types of buildings as well as the conditions of existing buildings before and after earthquakes.

3.2.4 Disaster Insurance Law No. 6305 of 2012

With the decree that became law on May 18^{th} 2012, the Decree Law No. 587 published in 1999 was abolished. In 2012, the application of compulsory earthquake insurance was extended to cover disasters other than earthquakes. This law provided for expansion to be carried out on the dwellings subject to compulsory earthquake insurance. These are; the independent departments within the scope of the Property Ownership Law, the buildings which are registered as land on the deed, and privately-owned immovable properties, the independent sections in these buildings used for commercial purposes. With this law, the rate of compulsory earthquake insurance within the housing increased from 28% to 36% by 2013 (National Report for Turkey Habitat III, 2014: 18).

3.2.5 Law No: 6306 on the Transformation of Areas under Risk of Disaster and Related Legislation (Urban Transformation Act)

Disaster Act No. 7269 could not perform the desired response to the natural disasters that Turkey had to confront. Known to the public as the "Urban Transformation Law", this law moved the perception of disaster alleged to have changed after the 1999 Marmara Earthquake into a different dimension. The law No. 6306 gathered all the legal regulations enacted before it under one roof (Aydıner, 2014). In other words, for the first time as a country that is continuously seeking legal regulations after disaster has occurred, a law was enacted which introduced more comprehensive regulations before disaster. The word risk which is not mentioned in Law No. 7269 is used forty-five times in the Law No. 6306 (Yavuzçehre and Aydıner, 2013).

The Urban Transformation Act has directed disaster perception to the processes prior to the disaster. In this context, Article 8 of the new law introduced important regulations about the prevention phase. The word 'mitigation' is clearly stated in the law and the Ministry and the Housing Development Administration are positioned as the authorized names of the process within the scope of the risk management statement. The Law No. 6306 has taken the legal arrangements before it to a new dimension (Aydıner, 2014).

A general urban transformation law eliminating the tradition of regulations after disaster put forward the risk management, established an important resource in terms of measures to be taken before the disaster, and aimed to involve the different actors in disaster management cycle.

In general, the mentioned laws and regulations are evaluated together. It’s seen that 5 of these are in force and 2 of these are abolished (Table 4).

Table 4 - *Laws and regulations in force and be abolished.*

Year	*No*	*Law-Regulation*	*Status*
1959	7269	Assistance to be Taken Due to the Measures Against Disasters Regarding Public Life	In force
1988	-	Emergency Regulation on Disaster Relief Organizations and Planning Principles	In force
1999	587	Compulsory Earthquake Insurance	Be abolished
2007	-	Regulation on Structures to be Built in Earthquake Regions (Earthquake Regulation)	Be abolished
2012	6305	Law on Disaster Insurance	In force
2012	6306	Transformation of Areas under Risk of Disaster and Related Legislation (Urban Transformation Act)	In force
2018	-	Turkey Building Earthquake Regulation	In force

3.3. Disaster and Emergency Management Presidency (DEMP) Foundation

Before the establishment of DEMP, the Turkey Emergency Management General Directorate, the General Directorate of Disaster Affairs, the General

Directorate of Civil Defense and the Prime Ministry Crisis Management Center are institutions that were all active. In accordance with Law No. 5902 addressing the Organization and Duties of the Disaster and Emergency Management Presidency, the aforementioned institutions were closed down. Due to the fact that many actors and institutions are involved in disaster policies, the work must be coordinated by a single institution. For this reason, the necessary infrastructure for the establishment of DEMP was established.

DEMP has adopted the aim of preventing and mitigating disasters, intervening in disasters and rapidly completing the post-disaster improvement efforts. DEMP is a business-oriented, flexible and dynamic organization that provides cooperation between all institutions and organizations of the country for planning, directing, supporting, coordinating and effective implementation of all necessary activities. This institution is the only authorized institution for disasters and emergencies, and as an umbrella institution, it operates its activities in coordination with other ministries, non-governmental organizations, the General Staff, Foreign Affairs, Ministry of Health, Transportation and Infrastructure, etc. in accordance with the nature and extent of the disaster and emergency (DEMP, 2019c). To this aim, the institution implemented a new disaster management model that changed the focus from "Crisis Management" to "Risk Management".

DEMP prepares and implements many action plans, strategies, programs and regulations for the pre-and post-disaster processes. The highlights of these are described one by one below.

3.3.1. National Earthquake Strategy and Action Plan (NESAP-2023)

In 2010, the Earthquake Advisory Board within DEMP started to work on the development of the Earthquake Strategy. In this process, some sub-commissions were formed and the process was discussed and directed by many experts. The reports of the committees were presented to DEMP and each subcommittee set a target, strategy and action plan according to the area of interest (Aydıner, 2014). NESAP's general guidelines was formed from the commission reports to learn about earthquakes and to be able to cope with the effects of the earthquake due to safe settlement and construction. The Urban Transformation Act and Natural Catastrophe Insurance Law were entered into force within the scope of this plan, which was put into effect in 2012, and the National Earthquake Research Program was launched to support disaster risk reduction efforts. NESAP-2023 provides a sample study that includes strategic approaches and a series of actions aimed at minimizing loss due to earthquakes. The DEMP-RED (DEMP-Rapid Earthquake Damage and Loss Estimation Software) program which includes the reflection of the general situation of the disaster area and estimated damage is active. The New Earthquake Hazard Map regarding Turkey, and updated "Earthquake Directives" were simultaneously published in the official gazette in 2018 and will be applied in 2019.

3.3.2. National Earthquake Research Program (NERP)

This program launched in 2012 by DEMP aims to solve the problems in priority areas related to earthquake disasters and provide implementations with result-oriented technological advances. In addition, it aimed to develop institutional capacity, support scientific research, and use the resources effectively by transforming this research into projects which can be transferred to the participatory structure and application.

The objectives of the NERP 2023 are;

- ❖ *Developing Knowledge of the Infrastructure of Earthquakes*
- ❖ *Earthquake Hazard Analysis and Development of Hazard Maps*
- ❖ *Provision of Earthquake Safe Settlement and Structure*
- ❖ *Protection of Historical and Cultural Heritage from Earthquakes*
- ❖ *Development of Training and Public Awareness Activities for Earthquakes.*

3.3.3. Turkey Disaster Response Plan (TDRP)

This plan was prepared in 2014 in order to specify the interventions to be carried out after any kind of disaster and to determine the duties, authorities, and responsibilities among all ministries, institutions, and organizations related to the works to be performed. Within the scope of TDRP, 28 National Level Service Groups were completed in 2015 and 81 Provincial Disaster Response Plans were prepared in 2016.

The main partners working in coordination with TDRP are:

- ❖ *Ministry of Interior*
- ❖ *Ministry of Transport, Maritime Affairs, and Communication*
- ❖ *Ministry of Health*
- ❖ *Ministry of Energy and Natural Resources*

- *Ministry of Environment and Urbanization*
- *Ministry of Family and Social Policies*
- *Ministry of Food, Agriculture, and Livestock*
- *Ministry of Finance*
- *Turkish Red Crescent*

3.3.4. Turkey Building Earthquake Regulation

The purpose of this regulation, published in the Official Gazette dated March 18, 2018, by DEMP is to:

Determine necessary rules and minimum requirements to design and construct all official and private buildings that need to be rebuilt, be modified, and be enlarged wholly or partially owing to the effect of earthquakes and evaluate the performances of current buildings which are under the effect of earthquakes.

3.3.5. Disaster Management and Decision Support System

The Disaster Management and Decision Support System was developed by DEMP to monitor and manage disaster and emergency processes in an electronic environment and provide decision support to authorities. This is a system built on Geographic information systems, with decision support mechanisms that can effectively manage national resources in case of a disaster. The Turkey Disaster Response Plan that makes up the infrastructure of Disaster Management and Decision Support System is operating within the scope of disaster planning, intervention, and remediation processes.

3.3.6. Turkey Disaster Risk Reduction Plan

The preparations for this plan explaining which tasks will be done when, how and by whom, have started to determine disaster risks and avoid and reduce these risks by taking all measures. While addressing the disaster risks in the Turkey Disaster Risk Reduction Plan, all public institutions and organizations, universities, private sector, non-governmental organizations, media, family, and individuals are expected to come together for governance.

3.3.7. Turkey Disaster Management Strategy Document and Action Plan

This plan is seen as the as is of the disaster management system that will enable the mitigation, preparation, intervention and post-disaster improvement efforts to be carried out in case of a disaster. The preparation and development of this plan by DEMP continue.

4. Conclusion and Discussion

Turkey is a country with a very high risk and occurrence of earthquakes when we examine the earthquake history, data obtained from many inventories and institutions, maps and historical events created in line. On the map of active faults updated by the Turkey Mineral Research & Exploration General Directorate 485 faults and fault segments which are capable of producing earthquakes of 5.5 have been identified. This data reveals the possibility of a major earthquake at any moment in Turkey. For this reason, it is seen as a country that requires many policies and strategies that involve all actors before and after the disaster.

In Turkey, the establishment of institutional structures and the enactment of legal legislation for disasters are generally after major earthquakes. One of these regulations is the disaster Law No. 7269 of 1959, which became the regulatory law after the 1939 Erzincan earthquake. This law brings together the disaster regulations enacted before that date under one roof. However, while it is considered important in terms of the number of actors and the authority it gives to local government units, there has not been a law in power to involve different actors in the disaster management cycle. This law adopted disaster-related demolitions and regulated the way in which post-demolition intervention and construction processes can be carried out (Aydıner, 2014).

There are no differences in the legal and institutional arrangements during the interval between Erzincan earthquake in 1939 and Van Earthquake in 2011. In particular, most of the processes prior to the 1999 Marmara Earthquake often has focused on post-disaster processes and the response and rebuilding processes that could be described as two phases of the disaster management cycle.

The legal regulations put into effect after the 1999 Marmara Earthquake are quite numerous; a total of 38 laws and decrees, 28 decrees, 6 regulations, 17 communiqués, and 9 circulars (Daşkıran and Ak, 2015). Despite these numerous laws and regulations one cannot say that Turkey is successful and effective in disaster management policy if economic loss and non-economic damages are taken into consideration in the historical context.

One of Turkey's most vulnerable areas against natural disasters is the lack of implementation of risk reduction programs. After previous ignoring the avoidance phase which is one of the most important stages of disaster management, the introduction of Compulsory Earthquake Insurance and establishment of TCIP as an institution to manage this process was a significant development.

In this respect, it has been ensured that rights holders are included in the mitigation efforts through compulsory earthquake insurance. However, these laws and practices has not been seen sufficient at the point of loss reduction (Başbuğ Erkan, 2007). There are many problems concerning the Compulsory Earthquake Insurance and the functioning of the TCIP system, which was implemented after the 1999 Marmara Earthquake. In addition, healthy funds and budget items for disaster could not create. The Special Consumption Tax, introduced in 1999 to cover the damages of the Marmara Earthquake, was used for other purposes.

The problem must be addressed with multidisciplinary approaches in order to make the cities, which are growing rapidly and in an uncontrolled manner, ready for disasters. Therefore urban transformation projects should be handled within the scope of the social, economic, psychological, and physical environment. A potential Marmara earthquake, which scientists predict to be of a 7.4 magnitude in the case of a single break, will affect the whole Marmara region, especially Istanbul (Moriwaki, 2019). In urban transformation projects, priority should be given to places where disaster risk is high and to buildings to be demolished (TMMOB Chamber of Civil Engineers, 2017).

A large part existing buildings in Turkey are unlicensed and illegal; a large part of dwellings consists of buildings over 20 years-old; nearly half of them are uninhabitable and must be reinforced against earthquakes. In 2019, some buildings collapsed in 4 different districts of Istanbul without any natural disaster. For example, in the Kartal district on 21 February 2019, 21 people were killed and 14 were wounded in a building that suddenly collapsed. In the expert report prepared for the relevant building; it was determined that the concrete used in the construction was made of sea sand and the sand was not washed and sifted. Also, the building was authorized to have 7 floors, however it had 9 floors.

The concept of Urban Transformation Law works to in the logic of demolishing and building and is used as a means of income. Legislation changes including the concepts of disaster, risk, urban transformation, zoning, public lands have made Turkey an element of profit-rant by starting from cities (TMMOB, 2017). According to Law No. 6306, the transformation has been handled only with its economic and physical dimensions, and the social problems that it will cause has been ignored. This law, which was issued after the Van earthquake in 2011 and which been stated that Turkey would solve the earthquake problem, stands out with many deficiencies and application problems. No effective work has been carried out on this law and the current plans have not been finalized.

In 2018, with the provisional article 16, which was added to the Zoning Law No: 3194, the Law of Zoning Pardon (Peace) enacted. In accordance with the provisions of this article, Regulation on Procedures and Principles for Granting Building Registration Certificate were issued (Pamukoğlu, 2018). The law, which provides for issuing a building registration certificate for a fee calculated in certain circumstances and has 11 million applications, covers structures made before December 31st 2017. Elimination of the conflict of citizens with the state, recording the buildings constructed in violation of zoning plans, unlicensed or contradictory to the annexes of permits are aimed to be legitimized. In accordance with this Law, if a demolition decision has been taken and an administrative fine has been issued for a residence, these will be canceled. In parallel with these developments, structures that are not certain to have sufficient engineering services will be legalized. This situation leads to these questions: What will happen to the structures that are vulnerable? How will they be controlled?

Connecting the Earthquake Research Department, one of the expert institutions involved in earthquake management, to the Ministry of Interior, has started a separate discussion. It would be more appropriate to connect this institution to the Ministry of Mineral Research and Exploration, which is an expert body. According to the Chamber of Geological Engineer; there are also a number of shortcomings in the implementations of institutions such as Earthquake Advisory Board, NESAP and NERP. The first one is that the Earthquake Advisory Board, which has not been convened since 2011, has not carried out any studies to provide public information about earthquakes. The uncertainty about the progress of the studies carried out within the scope of the NESAP-2023 prepared by DEMP in recent years is shown as another problem.

Regulations issued at various times regarding the aforementioned disaster risk in Turkey are available; however, these laws mostly focus on the post-disaster rehabilitation process. It can be concluded that Turkey is not successful in producing policies and strategies regarding the reduction of risks of earthquake.

References

Aydıner, T., 2014, *Doğal Afet Yönetişimi: Türkiye'de Doğal Afet Yönetimi Uygulamalarının Tarihsel Bağlamda Değerlendirilmesi*. Pamukkale Üniversitesi, Sosyal Bilimler Enstitüsü Basılmamış Yüksek Lisans Tezi.

Başbuğ Erkan, B., 2007, Türkiye'de Doğal Afet Sigortaları Kurumu'nun Başlangıcı ve Geleceği. In: Erkan, N. E., Güner, A., Demeter, K., *Afet Risk Yönetimi: Risk Azaltma ve Yerel Yönetimler,* Beta Yayınları, İstanbul, 141-153.

Daşkıran, F., Ak, D., 2015, *6306 Sayılı Kanun Kapsamında Kentsel Dönüşüm*. Yönetim ve Ekonomi Araştırmaları Dergisi, 13(3). doi: http://dx.doi.org/10.11611/JMER674

Kadıoğlu, M., 2008, Modern, Bütünleşik Afet Yönetimin Temel İlkeleri. In Kadıoğlu, M., Özdamar, E., *Afet Zararlarını Azaltmanın Temel İlkeleri*; JICA Türkiye Ofisi Yayınları No: 2, Ankara, 1-34.

Karamanoğlu, M., Ulay, G., 2017, Deprem Riski Yüksek Bölgelerde İç Mekân Düzenlemelerinin İncelenmesi (Tosya Örneği), *Kastamonu Üniversitesi Orman Fakültesi Dergisi*, 17 (1), 186-193.

Law on Compulsory Earthquake Insurance, 2012, (Law No. 6305). (2012/18 May). *Resmi Gazete* (Sayı: 28296). (Last accessed: 2019, 9 January). http://www.resmigazete .gov.tr/ eskiler/ 2012/ 05/20120518-4..htm

Ministry of Public Works and Settlement. 2004, *Deprem Şurası Sonuç Bildirgesi* (Last accessed: 2019, 5 January). http://www.imo.org.tr/resimler/ekutuphane/pdf/9695.pdf

Moriwaki, Y., 2019, Deprem Gerçeği ve Alınması Gereken Önlemler. *In Symposium organized by the Far East Community of Ondokuz Mayıs University (OMÜ),* Turkey.

National Report for Turkey Habitat III, 2014, T.C. Çevre ve Şehircilik Bakanlığı, (Last accessed: 2019, 5 February). https://webdosya.csb.gov.tr/ db/habitat/ editordosya/ file/HABITAT_III_ULUSAL_RAPOR_(turkce).pdf

Özkul, B., Karaman, E., 2007, Doğal Afetler İçin Risk Yönetimi. In *TMMOB Afet Sempozyumu, Kongre Sempozyum Bildiriler Kitabı,* Ankara, Turkey, 251-260.

Pamukoğlu, M., 2018, 7 Ağustos, *İmar Barışı nedir, ne değildir?*. Aydınlık Gazetesi, 1.

Şahin, Y., Pehlivan, A., 2007, Doğal Afet Risklerini Paylaşma Aracı Olarak "Deprem Sigortası. In *TMMOB Afet Sempozyumu, Kongre Sempozyum Bildiriler Kitabı*, Ankara, Turkey, 443-451.

TBMM, 2010, *Deprem Riskinin Araştırılarak Deprem Yönetiminde Alınması Gereken Önlemlerin Belirlenmesi Amacıyla Kurulan Meclis Araştırması Komisyon Raporu*. 23 (549). (Last accessed: 2019, 15 January). https://acikerisim.tbmm.gov.tr/ handle/11543/132

TMMOB Chamber of Civil Engineers, 2017, *Kentsel Dönüşüm Nedir? Sorular... Sorunlar...* Çözümler, Başak Matbaacılık ve Tanıtım Hizmetleri Ltd. Şti., Ankara.

Yavuzçehre, S. P., Aydıner, T., 2013, Afet Yönetim Döngüsü ve Algısı: Türkiye'de Afet Yasaları Üzerine Bir Değerlendirme. In: Bulut, Y., Eren, V., Karakaya, S., Aydın, A., *Kuramdan Uygulamaya Yerel Yönetimler ve Kentsel Politikalar*, Pegem Akademi, Ankara, 480-492.

Web references and Databases

ATAG, 2019, Geoscience Data Catalog (Last accessed: 2019, 18 March). http://atag. itu.edu.tr/v4/?p=135

DEMP, 2019a, Tarihi Depremler. (Last accessed: 2019, 12 March). https://deprem. afad. gov.tr/ tarihteBuAy

DEMP, 2019b, Earhtquake Catalog (Last accessed: 2019, 21 March). https://deprem. afad. gov.tr/ depremkatalogu

DEMP, 2019c, Neler Yapıyoruz? (Last accessed: 2019, 15 March) https://www.afad.gov.tr/ tr/23586/ Neler-Yapiyoruz

EM-DAT, 2019, The International Disaster Database. (Last accessed: 2019, 10 February). https://www.emdat.be/database

Turkey Disaster Information Base, 2019, (Last accessed: 2019, 20 March). https://tabb. afad.gov.tr/

TCIP, 2019, (Last accessed: 2019, 22 Mart). https://dask.gov.tr/zorunlu-deprem-sigortasi-istatistikler.html

USGS, 2019, Earthquake Hazards Program. (Last accessed: 2019, 20 February). https://earthquake.usgs.gov/

4. Risk Mitigation Through Local Building Knowledge: Turkish Van Region Case Study

Chiara Braucher[1], Mattia Giandomenici[2]

Abstract

Turkey's urban expansion process, has been rapidly growing in the last two decades and, according to the global trend of profit-based strategies, the effects of these urban policies have been harshly criticized for what concerns social and cultural spillover, leading to internal displacement and pauperization of the settled population. Moreover, the same policies have deeply transformed the relationships between the communities and their environment, especially in high seismic-risk area. Resilience, a controversial term referred here to policies and strategies for risk mitigation, is often abused in order to justify large-scale urban transformation projects.

The research was developed in 2016 to support alternative perspectives on risk mitigation strategies in the built environments; the research focused on the traditional constructive technologies in adobe, investigating their sustainability and their enduring capability to respond to the inhabitants housing needs.

This chapter proposes a proactive and participative approach to the construction at large, including the direct intervention from settled communities -still persistent but in serious decrease all around the world- as an important strategy for risk mitigation, an alternative to the profit-based approach of political decisions.

Keywords: risk mitigation; adobe; Turkey; earthquake; vernacular architecture.

1. Introduction

The proposed chapter presents a research carried out in 2016 in the Southern-East Turkish, specifically in the Van Region. It was formerly

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addressed to the study of traditional adobe building techniques (C.Braucher, M. Giandomenici, 2017), still largely widespread in the Region. This led to the analysis of local knowledge and to evaluate the possibility to propose these building techniques as a sustainable response to housing needs. As well, according to the high seismic-risk features of the Region, thanks to the direct experience and to the many interviews carried out with inhabitants and builders, it has been possible to examine the perceived risk of local people about vernacular architecture and the mitigation strategies developed by builders through centuries of construction practices (Varum, H., et al., 2015).

The subject of the research has been framed into a larger analysis about the Turkish national policies on urban transformations developed in the last decades, presented in the first part of the chapter (§.2). According to the reported considerations, it is clear that the reforms regarding the construction sector and economic policies in the contemporary neoliberal urban regime are deeply connected to the policies enacted after disasters occurred by the Marmara earthquake of 1999 and the Van earthquake in 2011.

An important analysis on the effects of the 'Law regarding the transformation of areas with disaster-risks', enacted after the earthquakes occurred in the Southern-east Turkish region of Van in 2011 (Tunç, 2012), argues the 'predominance of economic resilience over other kinds of resilience': the Ankara government, through a false narrative of "national mobilisation" around the necessity of urban resilient areas, aimed at legitimising the proposed law concerning disaster risk-mitigation while mainly supporting the economic outcomes. The manipulation of risk perception has been a political strategy for deep urban and cultural transformation (Tunç, 2012) (§.2.1).

The third part of the chapter (§.3) presents some interesting considerations carried out by Yildiz Technical University Team after the 2011 earthquake concerning the progressive loss of knowledge of traditional building practices by local population which brought to a progressive decrease of resilience. (Guney et al., 2013).

The cultural transformation caused by the reformation of the policies of the construction sector is one of the main reasons why it is impossible to define an efficient risk-mitigation strategy and it is on these considerations that the field research has been developed.

First of all, the research aimed to investigate and confirm the statement of the Yildiz research team (Guney et al., 2012), connecting the ability of traditional adobe masonry buildings to resist to earthquakes with their quality in terms of construction based on the *art rule* of builders (§4.1) .

The surveyed buildings have been listed and organized in different technological abacus according to their features in order to identify particular anti-seismic devices developed along the traditional building practices (§4.2). The aim of the research was to investigate how traditional buildings respond to the inhabitants housing needs and to contribute to the elaboration of risk-mitigation strategies based on local knowledge of building practices, both for the conservation of traditional building and for the new sustainable projects, according to a sustainable approach (Correia et al., 2015) (§4.3).

The last part of the chapter (§4.4) deals with the widespread prejudice in the eastern Turkish society concerning traditional buildings (Brown, R., 2012). Through the interviews collected during the field research it has been possible to investigate these prejudices, aware that any proposal on risk-mitigation strategy or transformation project should be integrated with the local culture.

2. Neoliberal urban and housing policies in Turkey

Concerning to Turkish history, urbanization can be explained through three historical phases; the period before 1980, the period between 1980 and 2001, and the period after 2001 (Lelendais et al., 2015).The first phase corresponds to the beginning of urbanization in the 1950s, and it is clearly related to the high rate of rural migration. This period is marked by the absence of public policy on housing. The housing question was never entirely addressed as a policy in the political agenda of changing governments, and housing needs was long-time managed by individual initiatives by constructing informal settlements called *gecekondus* (Choueiri, 2008). The process of settlement through the act of land taking and self-construction of shelter by people, was not legal. The government found this convenient, since the costs and labour of urbanization were sustained by the migrants themselves. (Bekemen, 2014).

The rise of neoliberal economic rules began in Turkey during the 1980s. The government progressively lost its control on the market under the rule of former Prime Minister Turgut Özal. In terms of anti-labourism and neoliberal centralisation of state power, Turkish government under Özal engaged in real shock therapy as its counterparts did elsewhere in Europe accompanied by an export-led growth strategy (Bekemen, 2014).

During the period between 1980 and 2001, economic development dominated Turkey’s public policy, and led to some large-scale development projects such as the Southeast Anatolia Project (GAP), which involved the construction of 20 dams for hydroelectric energy production (Yuksel, 2006).

This era was also associated with the development of building co-operatives and with the introduction of larger building contractors within the housing market, identifying inner-city gecekondus as potentially profitable sites. Government had not attempted to regenerate gecekondus areas, fearing a backlash from voters and subsequent electoral defeat (Tunç, 2012).

This situation was only changed by two major crises in recent Turkey history:

- The big earthquake of 1999 in Marmara Sea, close to Istanbul, which caused the death of 16,000 people and the destruction of 20,000 buildings, underlining the security problem in the construction sector.
- The financial crisis of 2001 and the rise of neoliberal urbanisation through large urban transformation projects. The link between the financialization of capital and the built environment through new mechanisms is an effect of the IMF- led economic restructuring program in Turkey (Tunç, 2012).

These two events define a new period concerning urban transformation policies, that correspond with the political rise of AKP in 2002 elections. The neoliberal economic choices of the AKP had actually two main characteristics. The first was the support of Islamic capital groups close to the party, in order to consolidate their power as a unity of politically dominant class and capitalist group (Lelendais et al., 2015).

The second was the promotion of urban planning and development projects by accelerating the construction industry, which had already boosted during 1990s via the arise of Real Estate Investment Trusts and the privatisation of a number of urban public constructions and lands (Enlil, 2011).

In this sense, urban entrepreneurialism denotes an array of governance mechanisms and policies aimed at nurturing local and regional economic growth by creating a business environment propitious to capital accumulation and investment (Harvey, 1989).

2.1. Disaster risk management as a source of profits.

Starting from 2001, a new system of urban planning began to spread. By implementing a number of legal and institutional reforms, the AKP decided to rearrange the governance of Turkish real-estate markets and urban planning, with significant consequences for the socioeconomic geography of cities and the rural environment. The first stage of this reorganization was the increase of the advantages of Mass Housing Administration's (TOKI) in 2003 with the law no. 4966, allowing all state lands to be used by TOKI in order to define lands for housing (www.toki.gov.tr).

In 2007, by the law no. 5609, TOKI became the sole authority in determining zones of construction and the trade of public lands. The Van earthquake in 2011 triggered a new wave of urban transformation. With the 'law regarding the transformation of areas with disaster-risks' enacted in May 2012, the government approved regeneration projects all around the country under the control of TOKI, leaving much discretion in defining 'risky zones'.

During the preparation of the law, the government built its legitimising dissertation upon the law's importance in disaster risk mitigation and attempted to create a spirit of 'national mobilisation' around the importance of this law.

However, as the general evaluation of the existing disaster risk management and urban planning policies, as well as the law's document soon revealed, this second wave of urban transformation did not differ in essence from the one pursued through 2000s, except for its strategic use of disaster risk mitigation. (Tunç, 2012).

Previously a non-profit public institution for social housing, the TOKI today has permission to undertake 'for-profit' housing projects on state land, either through its subsidiary firms or through public–private partnerships, all to raise funds for the so-called construction of public housing.

The following table reveals, for example, the TOKI projects realized in 2012.

Table 1 - *Official websites of Mass Housing Agency, 2012.*

Social Housing	6.51%
Public Administration Housing	18.24%
For Profit Housing	75.25%

TOKI is an instrument for creating profit through both the development of projects in areas with high land rent and increasing land rents by developing construction projects.

The restructuring of the economic policies in the construction sector in this neoliberal urban regime can be summarised as follows:

- The state appears as the main propulsive force and developer via the mobilisation and the increase of politico-economic competences of various public institutions and the establishment of a new legal framework on property and urbanisation.
- Urban transformation and large-scale development projects are the main tools of intervention in land management.
- Urban transformation and UDPs are considered as catalysts of economic growth and the creation of a new capitalist and conservative class implicated with the government.
- The decision-making and the construction process of urban projects doesn't include a democratic debate with the inhabitants and has a top-down authoritarian attitude, based on security stance, ambiguously defined. (Lelandais, 2015)

In addition to these economic reasons, looking at the urban transformation process and at the legal framework which made it possible, it is clear that there has also been a social re-organization aimed to push the economically weak population to the suburban areas. (Dikec, 2009)

With this new urban regime, it was possible to undertake planning and renewal projects anywhere in Turkey, regardless of the intended outcome. Moreover, new laws have given public institutions, through TOKI (Fig. 1), the power to carry out such projects, including expropriation, repressing the inhabitants' right to opposition, resistance and negotiation.

Within this framework, city and land management is not perceived as a social human project but rather as a source of profit.

Figure 1 - *Diyarbakir suburbs 2016.*

3. 2011 earthquakes in Van Region

According to this general framework and to the widespread criticism on Turkish urban policies development, it is interesting to introduce the field research developed in 2016 in the high-risk seismic area of Van Region through a general framework of the area and the report of Yildiz Technical University team after the violent earthquake that hit the region in 2011 (Kuruscu et al., 2014).

The region presents a generally mountainous character, rich of rivers and lakes and the Van Lake is clearly the bigger one. With an average altitude of 1700 m, the region is characterized by a continental climate with cold, snowy winters and hot dry summers. Van region is divided in 13 districts with 22 municipalities and more than 580 villages with approximately 1 million 3 hundred thousand inhabitants. Nearly half of the population of the region is concentrated in Van city centre and its surroundings, while more than 400 thousands of people are still leaving in rural settlements, strongly related with their territory resources and traditional lifestyle.

The Eastern Anatolian region is one of the most seismically active regions in the world: it lies on the Anatolian plateau, one of the minor plates, with Aegean plate, created by the collision between Arabic and Eurasian plates. (Bayrak et al., 2008.)

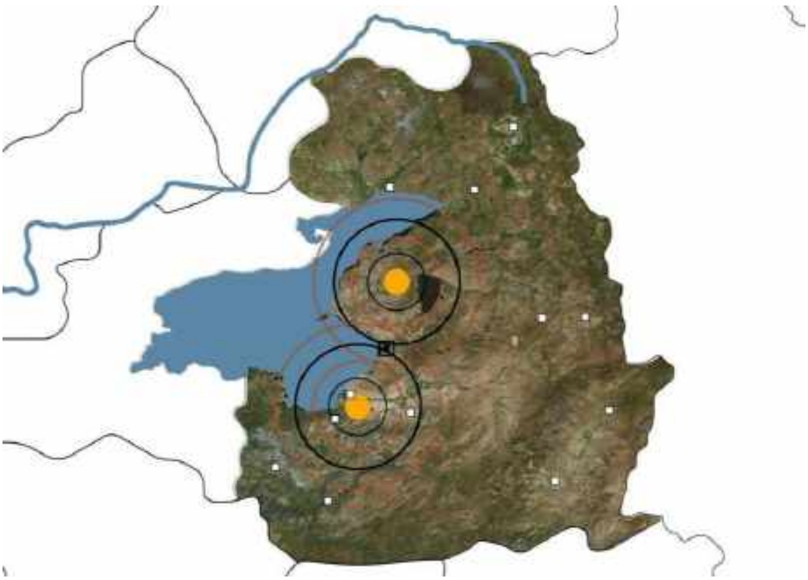


Figure 2 - *Epicentre map 2011 Earthquakes.*

Along the history many earthquakes had occurred in the East Anatolia region, the major earthquakes occurred in the year 1111 causing damage and having a magnitude around 6.5-7. In the year 1646 or 1648, Van was again struck by magnitude of 6.7 quake killing around 2000 people. In 1881, magnitude of 6.3 earthquakes near Van killed 95 people (Guney et al., 2012).

In 23 October 2011, Van city, in Eastern Turkey, was hit by a large earthquake at 13:41 (10:41 GMT), on Sunday afternoon of magnitude 7.2. This earthquake had a shallow hypocenter depth of about 10 km. The Van earthquake, where epicenter was about 16 km north of Van city at Tabanlı village, between Ercis Town and Van city, devastated the area (Fig. 2). During this earthquake 644 people died, 2608 people injured and 2307 buildings totally collapsed.

On November 9, 2011, the second Van-Edremit centered earthquake occurred at 21.23 (18.23 GMT) of magnitude 5.6. The epicenter of the earthquake was near the Edremit town south of Van.

The buildings previously having slight or medium damage in Van city center now totally collapsed or were heavily damaged (Guney D., et al. 2013).

Focusing now the attention on the behavior of adobe masonry buildings, or more in general on unreinforced masonry structures, is possible to highlight some interesting considerations underlined by Yildiz Technical University reports carried after the 2011 Van earthquakes. Upon masonry building details the damages were strictly connected with the qualitative poorness of construction knowledge: in fact, most of the masonry buildings had damages but there were also adobe, brick or stone masonry buildings that had no damage (Fig.3) (Guney D., et al., 2012).

When their construction year was investigated, it was possible to understand that the older buildings had no or slight damages. The reason might be in the organization of the foundation. Building masters, being aware that rigid building on rigid soil might be dangerous for the building, had introduced special techniques to change the natural frequency of soil or provided flexible footings at high seismic zones. As also pronounced by old villagers the foundations of masonry village houses were constructed on a layer of ~40 cm sand till 1960’s. The thick layer of sand, gravel or stone pieces provided a change in the natural frequency of soil as well as adequate subsurface permeability to avoid a high water table condition. It is possible to argue that the traditional construction method was forgotten, that’s why many masonry buildings had suffered during these earthquakes (Guney D. et al 2015).

Therefore, one of the most significant problem about seismic performances of masonry buildings it is then referred to the lack of memory upon construction matter, the lack of knowledge due to a relatively shortage of technical studies regarding strategies of heritage conservation. The aim of the research refers to the improvement of vernacular construction technologies knowledge, and it is in this direction that the paper has to be read. Using simple and economic technological devices, the seismic performance of the unreinforced houses improves.

Figure 3 - *Adobe house with anti-seismic presides*

According to this goal, the education of local workers and contractors is very important: skilled workmanship and the appreciation of the traditional construction methods will increase seismic resistance of unreinforced masonry buildings. For this reason, it is necessary to develop guidelines for the construction of unreinforced masonry buildings, especially in rural areas (Guney D. et al., 2015). The field research then, aimed to increase the scientific knowledge above vernacular architecture and anti-seismic historical presides through observation and interviews.

4. Field Research and Outcomes

The field research is a cognitive practice of places direct experience, based on observation and interviews. Concerning rural and urban settlements, as material expression of relationships in between men and with the surroundings environment, the direct experience of places provides essential data for an aware territorial framework and social-cultural context.

The observations of existing structures, of their damages due to the passing of time, to the abandonment or to extraordinary traumatic events as the recurring earthquakes, from whom the region is interested, provides many extremely important technological information.

At the same time, interviews to inhabitants and builders represent a direct testimony about technological characteristics and functions of the buildings. Every meeting, tale or explication is part of the oral history of a place and contributes to the development of a more conscious point of view, necessary to advance hypothesis and to imagine coherent answers. The research has been implemented walking, crossing places and sharing time with their inhabitants.

The field research has been carried out, according to this framework, particularly searching for the anti-seismic devices of traditional buildings in the Southern-East Turkish region.

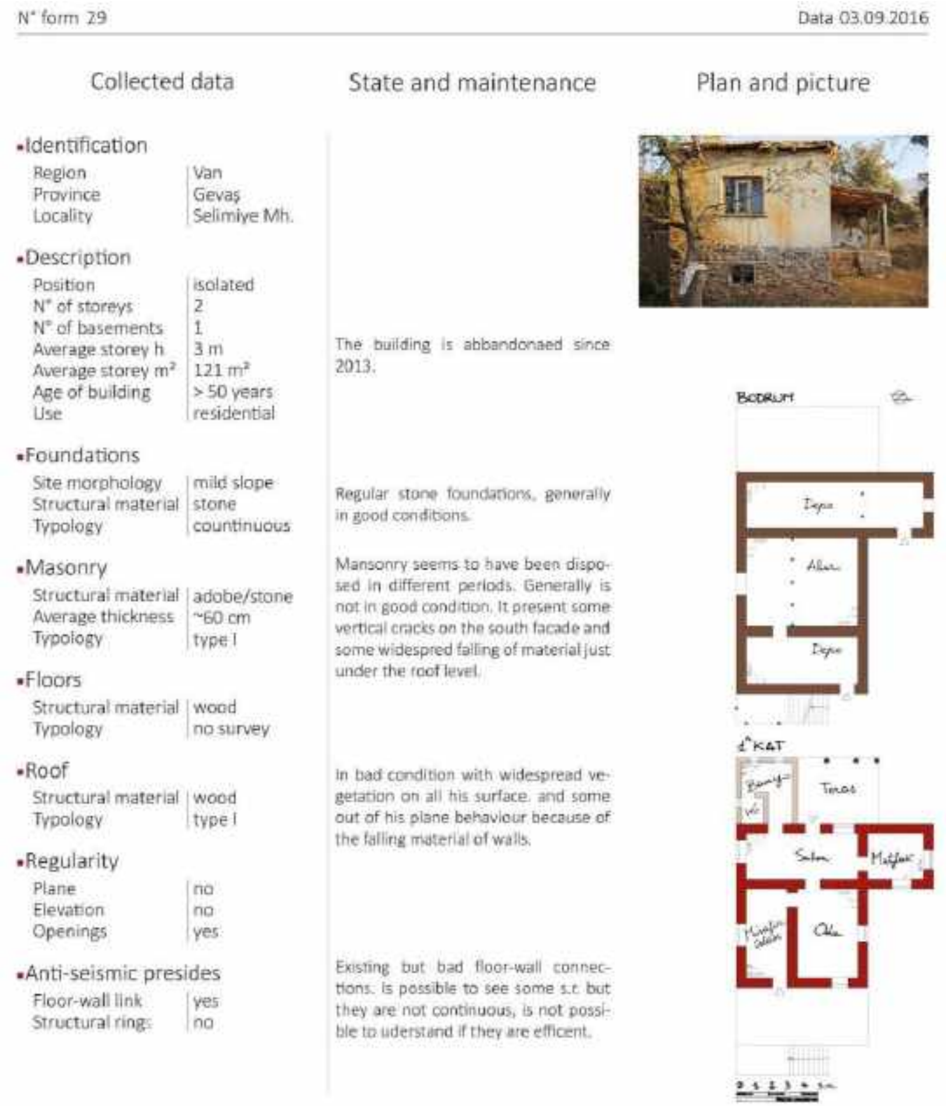
The research was in specifically carried out in three districts of Upper Mesopotamian Region in the East of Turkey: Tuşba (Van city), Gürpınar and Gevaş. These areas have been study by the authors between the end of August and the end of September 2016.

4.1. Methods and Tools

The research focused specifically on the survey of adobe houses, it seemed necessary to elaborate a support that allowed to systematically organize a large number of information for each building. For this reason a specific form was elaborated in order to collect and synthesize the data that were considered significant (Braucher, C., Giandomenici, M., 2016.) for the definition of the "rules-of-tombs" from structural and architectural point of view that characterize vernacular architecture of Van Region.

The form, was based on AeDES model (Baggio, C., et al., 2007), elaborated by Italian Civil Protection in order to carry out the first level emergency assessment of damages due to earthquakes events.

All of the considerations, gathered thanks to the 50 surveyed buildings and to the interviews, have been organized in 50 schedules divided in three columns (Fig. 4):


N° form 29 — Data 03.09.2016

Collected data		State and maintenance
•Identification		
Region	Van	
Province	Gevaş	
Locality	Selimiye Mh.	
•Description		
Position	isolated	
N° of storeys	2	
N° of basements	1	
Average storey h	3 m	The building is abbandonaed since 2013.
Average storey m²	121 m²	
Age of building	> 50 years	
Use	residential	
•Foundations		
Site morphology	mild slope	Regular stone foundations, generally in good conditions.
Structural material	stone	
Typology	countinuous	
•Masonry		Mansonry seems to have been disposed in different periods. Generally is not in good condition. It present some vertical cracks on the south facade and some widespred falling of material just under the roof level.
Structural material	adobe/stone	
Average thickness	~60 cm	
Typology	type I	
•Floors		
Structural material	wood	
Typology	no survey	
•Roof		In bad condition with widespread vegetation on all his surface. and some out of his plane behaviour because of the falling material of walls.
Structural material	wood	
Typology	type I	
•Regularity		
Plane	no	
Elevation	no	
Openings	yes	
•Anti-seismic presides		Existing but bad floor-wall connections. Is possible to see some s.r. but they are not continuous, is not possible to uderstand if they are efficent.
Floor-wall link	yes	
Structural ring	no	

Plan and picture

Figure 4 - *Resume schedule, provided one for each house.*

- the left one concern the geographical identification and the general description of the building. Then, the structure is analysed providing specific descriptions of macro-elements characteristics (foundation, masonry, floors, roof), specific considerations about the regularity features, and the presence of the anti-seismic presides;

- in the right column, is provided a general descriptive picture of the building in order to represent the aesthetical features of the building and its plan, useful to describe the different functions of the building spaces. The different colours of the walls, reported in the plan, explain also the different building material (stones, mud bricks, concrete blocks);

- the central column is more specific and different for each building: concerning all the data collected through the interviews and the impressions due to the direct observation of the element's qualities and their state of maintenance, are here reported particular transformations, specific structural problems like cracks, failing of material or disconnections, and the particular finishing details, plasters and decorations.

According to the consideration expressed by Yildiz University Team reported above (Guney et al., 2015), it is important to underline that the surveyed houses present an average age around 50 years old. This means that most of them, have been hit and resisted at least to three or four important seismic events and to dozens of smaller activities. It is also important to remember that these 50 houses are just a small part of the existing adobe buildings, and really few examples in respect to all the adobe buildings present in the region.

Thanks to the interview carried out to inhabitants and builders, it has been possible to gather information regarding the mixture used for blocks and its process of aging, the typology of the mortar, the foundations building method, all of the expedients in the construction process, till the waterproofing of the roof and the disposition of the channels.

4.2. Outcomes on constructive technologies

The information collected during the field research allowed to provide a comprehensive catalogue where it is possible to systematically identify specific features and recognize recurrences and similarities among the surveyed buildings. Along the research it is possible to recognize the repetition of similar constructive choices regarding blocks disposition, the floors and the roof technologies. According to this observations, different Abacus for the structural elements were elaborated and reported in the research results.

Concerning the vertical structural elements, it has been recognizing a general recurrence of 60 cm thickness for the wall sections (just few cases are 50 cm) reached through the combination of 3 different types of mud-bricks sizes and arrangement.

The ‘Floors Abacus’ contains three kinds of constructive technologies. All of them are structurally made by wooden beams and they differ for the composition to the secondary spanning choices. All of them are here analysed in their different layers and considering the opportunity to provide different finishing touches. Beams and also the other wooden layers are made using the popular tree (*kavak*), largely widespread in the region, in the places where there is not an evident deforestation process

Concerning roofs, it is firstly important to report that most of the buildings, quite all of them, presented the traditional flat roof (type I) until 10-15 years ago. Then, because of the maintenance process that these kinds of roofs require and because of the snow in winter, many surveyed buildings now present metal sheet, shaped differently according to the plan dimensions and the inhabitant personal choices. All of them are reported in the Roof Abacus with some indications and it is interesting to highlight that, also if metal sheet is later added, the earthen finishing (at least of 5-10 cm) disposes over the last floor, is continuing to provide the thermal comfort expected by the people used to the 20-25 cm traditional heavy roof.

Concerning the anti-seismic presides, it was possible to observe different types of connections between bricks (ammorsamento), often well done. One of the most interesting technological elements observed during the field research were the wooden ring beams (hattıl) largely widespread all around the region as an important seismic preside. The element, made by two small (5x5 – 10x10) wooden beams, follows the plan section all around the building walls. The two parts are connected each other by wooden sticks placed every 40-50 cm.

The empty parts are filled with the same earthen mixture used for the blocks to reach the wood level in order to restart the blocks courses (Fig. 5).

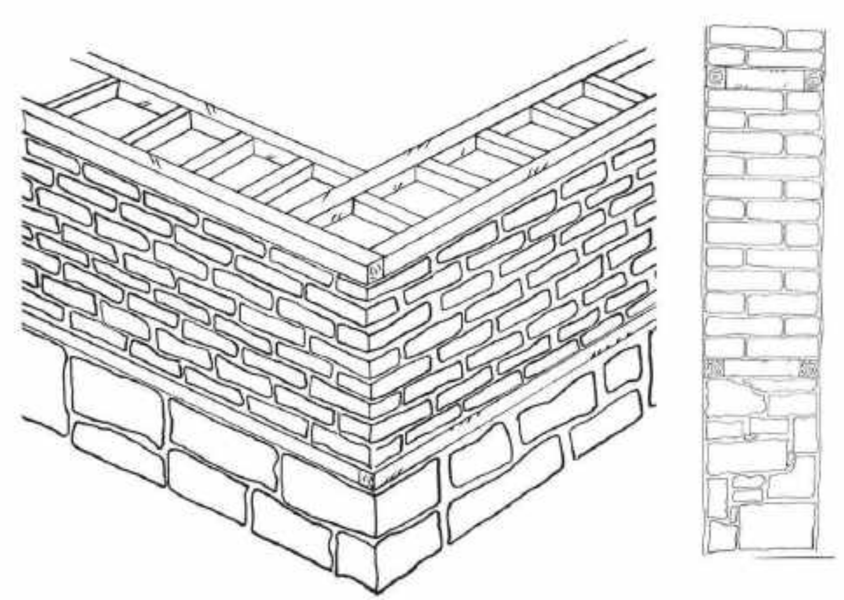


Figure 5 - *Wooden beams, seismic preside.*

4.3. Outcomes on constructive process

A common feature observed in all the surveyed houses, a generally widespread habit in the region, is self-construction. Building with earthen blocks and wooden technics is still a living knowledge for people.

Most of the inhabitants are able to deal with progressive transformation in order to adapt the house to the changeable needs of the family. Growing of inhabitants, functional adaptation, technological improvement lead people to directly operate on the building structure. Maintenance interventions are also necessaries in order to keep efficient, for example, the external finishing of walls or the earthen roof.

A significant observation derived from the field research, is the widespread decision to add over the traditional flat roof a light wooden structure to support sloping metal sheet. The new roof guarantees a good protection to the abundant rains and snowing days especially in winter times and does not need yearly maintenance as earthen roof require. Anyway, the addiction does not compromise the climatic performance of the earthen covering, maintained under the sheets.

Observing building plans, is easy to guess the addiction of rooms from the initial simple modular form, through the inhabitant's interviews was possible to get many information about that. It is furthermore interesting to highlight the characteristics of construction material of transformation. Old addictions were carried through earthen blocks but since concrete blocks came to be easily accessible to people they preferred, not always anyway, to do it with them. However, interviews also revealed that concrete blocks addiction are less comfortable from climatic point of view and sometimes, during the earthquakes occurred in the region, they presented more problems than earthen-built part. according to the high number of building surveyed and generally observed, it is possible to conclude that they well resisted to many different earthquake and that, starting from the analyses of their technologies, is possible to elaborate risk mitigation strategies both for the traditional buildings and for the new construction projects.

4.4. Discussion on preconceptions about traditional buildings

Thanks to the direct experience of the field research, it has been possible to verify widespread presence of preconceptions and prejudices on the earthen (kerpic) construction matter and on vernacular architecture in general. Although the people who are still living in their adobe houses demonstrate to appreciate their living condition, is generally observable the lack of awareness about the presence of earthen building around the region, and a suspicious attitude on the matter.

In the following paragraphs some of these preconceptions are discussed moving directly from some sentences collected during the interviews to the inhabitants (Fig. 6).

Figure 6 - *Van rural area 2016.*

4.4.1. "Kerpic houses are not good for earthquakes"

As far as adobe technologies were not chosen as a profitable construction material, there is a deep lack of studies and about them, implemented only by scientists who saw its potentiality concerning its qualities in terms of environmental, economical, social and cultural values.

This lack of knowledge is real but not unbridgeable; in order to fill up this lack many strategies and studies can be provided. First of all is possible to underline a comparative approach between adobe and traditional cooked blocks. This technology was deeply analysed because of its widespread utilisation in historical centres and monumental architecture through a deductive method.

Starting from the wide knowledge about this technology is possible to focus on the analogies with the adobe one in order to understand the behaviour of mud bricks masonry.

The similarities concern multiple aspects between them: first of all the building process doesn't present any significant difference, the disposition of the brick element follow the same rules and devices.

The whole structure is composed by the same elements: massive walls divided in piers and spandrels as resistant elements, wooden elastic floors or brick vaults, several types of roofs due to climate, material availability and tradition. Masonry structures are generally particularly vulnerable to earthquake forces and several damages can occur during this extraordinary situation. They can be divided in two main types: in-plane damages, out of plane damages.

The main difference between the two techniques it is the resistance of the brick as a single element, the uncooked one normally presents a resistance 3 times less than the cooked one.

Considering these data, is possible to analyse the structural qualities of existing constructions according to their maintenance state and to gain important data to improve the knowledge regarding adobe construction. Through the extension of awareness is possible to implement intervention on built heritage and to project new building according to the art rules provided by the existing ones.

With more detailed analyses, is even possible to project new buildings with different spatial requirement. Is possible to compare analysis of traditional masonry (bricks stone) with the mud bricks masonry in order to predict the structural behaviour of buildings and to carry on quantitative analyses using numerical programs normally used to study masonry ordinary buildings.

4.4.2. "Kerpic houses are poor people don't want them"

Apart from the evident assumption that generalization can never be done regarding people needs and desires, two different questionable points are contained in this statement.

The concept of poorness is not proper of any kind of material itself. It is instead a category depending on a more general definition tied to the ruled class developing idea which fix, separate and determinate a hierarchical scale for many aspect of life in a specific geographical and social area.

Furthermore, about traditional building materials like adobe, stone and, until few years ago, also wood, they were categorized as poor and inadequate to answer to modern housing standards but, according to the contemporary goal of sustainability they can instead represent an interesting field of research also for new projects.

5. Conclusions

According to the general criticism widespread in the contemporary analyses about neoliberal urban transformation policies, it seems to be important to investigate alternative practices in order to develop efficient and suitable policies of risk mitigation for high-risk area.

The research presented in this chapter deals with seismic risk and moves from the quick analyses and considerations reported after the last destructive earthquake of 2011 in Van region, into an in-depth research on traditional building technologies and local housing culture in order to verify the effective persistence of them as an appropriate answer to people housing needs. The observation of existing structures and their damages due to the passing of time, abandonment or traumatic events which interested the area, is extremely important to gather technical information. The interviews to inhabitants and builders represent a direct testimony about technological characteristics and functions of the buildings. Every meeting, tale or explication is part of the oral history of a place and contributes to the development of a more conscious point of view, necessary to advance hypothesis and to imagine coherent answers for people needs. The results confirmed a still widespread presence of traditional buildings and the hypothesis of Yildiz Technical University about the loss of constructive knowledge and the low quality of construction practices enacted in the last decades as the main reasons of the destruction after the earthquake.

The outcomes reported about constructive technological and constructive process would represent an empirical base to increase awareness on such a building heritage, in order to elaborate strategies for its maintenance and to develop technic guidelines for sustainable and traditional construction projects.

The numerous traditional buildings, still inhabited and well maintained by people, suggest the opportunity to consider these technologies as a field to be investigate in order to materially reduce the seismic risk, looking for a cultural rehabilitation of them in the socio-cultural widespread perception through practices of information and communication.

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References

Bayrak, Y., Öztürk, S., Koravos, G. C., Leventakis, G. A., & Tsapanos, T. M., 2008,. Seismicity assessment for the different regions in and around

Turkey based on instrumental data: Gumbel first asymptotic distribution and Gutenberg-Richter cumulative frequency law. *Natural Hazards and Earth System Sciences*, *8*, 1, 109-122.

Baggio, C., Bernardini, A., Colozza, R., Corazza, L., Della Bella, M., Di Pasquale, G., & Papa, F., 2007, Field manual for post-earthquake damage and safety assessment and short term countermeasures (AeDES), *European Commission—Joint Research Centre—Institute for the Protection and Security of the Citizen, EUR*, *22868*.

Bekmen, A., (2014), State and capital in Turkey during the neoliberal era, *Turkey reframed: Constituting neoliberal hegemony*, 47-74.

Braucher, C., Giandomenici, M., 2016,. Lessons from Van territory: step 1. In *International Conference Kerpiç'16*, 99-111.

Brown, R., & Maudlin, D., 2012, Concepts of vernacular architecture, *The SAGE handbook of architecture theory*, 340-368.

Choueiri, Y. M. (Ed.), 2008, *A Companion to the History of the Middle East*, John Wiley & Sons.

Correia, M., Dipasquale, L., & Mecca, S. (Eds.), 2014, *VERSUS: Heritage for Tomorrow*, Firenze University Press.

Correia, M., R., Paulo B. Lourenço, and Humberto Varum, 2015, *Seismic Retrofitting: Learning from Vernacular Architecture*. CRC Press.

Dikeç, M., (2009), Space, politics and (in) justice, *Justice spatiale-spatial justice*, 1, http-www.jssj.org.

Enlil, Z. M., (2011), The neoliberal agenda and the changing urban form of Istanbul, *International Planning Studies*, 16, 1, 5-25.

Güney, D., Kuruşcu, A. O., & Arun, G. (2013). Damage Evaluation of Adobe Houses after Van Earthquakes (23 October 2011 and 9 November 2011), *International Conference Kerpiç'13,* 11-15.

Güney, D., (2012), Van earthquakes (23 October 2011 and 9 November 2011) and performance of masonry and adobe structures. *Natural Hazards and Earth System Sciences*, *12*(11), 3337.

Güney, D., Kuruşcu, A. O., & Arun, G. (2016). Damage Evaluation of Masonry Buildings after Van Earthquakes in 2011. *International Journal of Architectural Heritage*, *10*(2-3), 269-280.

Güney, D., Aydin, E., & Öztürk, B., (2015), The evaluation of damage mechanism of unreinforced masonry buildings after Van (2011) and Elazig (2010) Earthquakes, *Journal of Physics: Conference Series,* 628, 1, 12-66. IOP Publishing.

Harvey, D., (1989). From managerialism to entrepreneurialism: the transformation in urban governance in late capitalism. *Geografiska Annaler:*

Series B, Human Geography, 71, 1, 3-17.

Kuruşcu, A. O., Deniz, G., and Gorum, A., *Seismic Behaviour of Vernacular Masonry Buildings During 2010 and 2011 Earthquakes in Turkey*, 2014, Guimarães.

Lelandais, G. E. (2015). Urbanisation under Neoliberal Conservatism in Turkey. *Research Turkey, Centre for Policy and Research on Turkey*,

Tunc, G., (2012), *Seeking Resilience in the Future of Turkish Cities: What May the Upcoming 'Urban Transformation Wave' Bring?*, Department of Public Administration Uludağ University, Bursa, Turkey, 4, 7, 54-67.

Varum, H., Rodrigues, H., Lourenço, P. B., & Vasconcelos, G. (2015). Seismic behaviour of vernacular architecture. *Seismic Retrofitting: Learning from Vernacular Architecture*, 151.

Yuksel, I., (2006), Southeastern Anatolia Project (GAP) for irrigation and hydroelectric power in Turkey, *Energy exploration & exploitation,* 24, 4, 361-370.

Section II

Communication and Prevention Strategies of Seismic Risk

5. Communication-Based Prevention Strategies: A Draft Model Proposal

Andrea Volterrani[1]

Abstract

Is it possible to prevent something through communication? Or at least to raise people's awareness through communication? The chapter presents and discusses a draft model for the prevention strategies in relation to the risk of natural disasters through an analysis of the Italian campaign "I don't take risks". The draft model consists of: a) the four stages of the change of communication-based prevention strategy process: 1) perception and relevance: how to sense a theme or a significant problem, 2) knowledge: how to deepen the characteristics of the issue or problem that I consider relevant, 3) incorporation: how do I incorporate the theme into the imaginary, and 4) change: how behaviors and attitudes can change; b) the four principles of daily work for the prevention of communication: 1) monitor the media, 2) read the public space, 3) deal with the operators of information, and 4) analyze the media landscape of the theme; c) the five dimensions for the communication-based prevention strategy: 1) popularity of the messages, 2) use of narratives, 3) ritual in communication actions, 4) colonize the imaginary: imaginary appropriation of the market communication, and 5) media education: building knowledge and awareness among citizens; and d) the four phases of the impact assessment of prevention: 1) communication objectives, 2) community analysis, 3) measurement of involvement and participation, and 4) impact assessment.

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The article has been written in cooperation with Dr. Angelica Spampinato with particular reference to paragraph 6.

Keywords: prevention communication, risk, radicalization, change

1. Preface

Cultural change has always been a central focus of social analysis. Understanding what symbols, values, and behaviors are and how they change, leads to understanding in-depth changes and social innovations.

Communication is the catalyst and the core of this change, but often because of its characteristic of seeming naturalness, each individual and community tends to overlook and minimize the visible and invisible potential of communicative actions (Couldry, 2012; Couldry, Hepp, 2016).

This potentiality and inner characteristic are even more important for prevention communication. In fact, if communication is the main focus of the change in the buying patterns market, along with the strengthening and visibility of the brand, what often comes into play in prevention communication is the identity change of both the individual and collective.

Furthermore, the object of change issues is often controversial and contradictory – for example, there may be communication campaigns to counter the risk of pathological gambling, yet there are also explicit and implicit messages inviting you to "try your luck" in some state lottery - from both scientific and common sense points of view, and sometimes, from a moral one as well (e.g., a campaign against homophobia which urges people who have very different value-convictions on the subject to change their opinion). Three different aspects – science, common sense, and morality – involving differentially individual and collective social imaginary (Jedloswki, 2008, p. 134).

This is the first reason for why coming up with and planning prevention communication is not simple: when you touch things that are part of our deepest convictions or which are taken for granted in our daily lives, every fact, interpersonal communication, or media that tends to problematize, you do not have an easy time of it. The roots of imagination are deep and firm, and are unlikely to be affected unless specific events capable of subverting ideas, meaning, and linked images occur.

In the work that follows we will deal with the process of change by referring to an empirical situation, an Italian national campaign to reduce seismic risk, where prevention communication is a potentially unavoidable element. The case focuses attention on the multi-year experience of a communication-based prevention campaign promoted by the Italian Civil Protection Department together with voluntary associations. The model we are presenting has been applied and is also applicable to contexts where communication-based prevention does not refer to natural disasters, as for example in the case of prevention of radicalisation of second-generation young people or as for example in the case of prevention of social diseases such as diabetes.

However, before going into the discussion of the case, we must try to better understand model and what are the processes of change of the individual and collective social imaginaries.

2. The processes of change: a focus

The changes that can be connected to prevention communication are neither simple nor immediate.

But in order to propose an issue that is not just fatalistic, we must try to analyze the process that could lead to changes in the experienced reality. At least four different stages have been identified: a) the perception, selection, and relevance of the topic or issue; b) the knowledge of the topic or issue; c) the incorporation of the issue or problem; and d) the possible change of attitudes and behavior in relation to the issue or problem (Figure 1).

Figure 1 - *Model of communication on prevention.*

2.1. Perception of a theme or a problem

The perception of the subject by an individual is an important step. For example, I may be horrified by a car accident but do not feel that I can be involved if I do not adopt a different behavior. However, finding that particular communication process which makes me "switch on" my eye is not easy. Seeing what is and what is not relevant to me from among the countless communication processes around me is the first step. Beyond the theories of persuasion that emphasize the ability to build messages that are more noticeable than others, the issue at stake here is another: What are the selective processes that cause a priority issue, a problem, to be strongly tied to my identity aspect, my behavior, and my attitudes? In the above example, it is not easy to see what image or video, such as sequences, or which safety issue in the road driving narrative will be most able to make me turn on the selection (Lotto, 2017; Sloman, Fernbach, 2017). The processes by which we interpret and select media content are very complex (Couldry, Livingstone, Markham 2010). One on which it is important to dwell is that the role of individuals, and the communities they belong to, are established elements in the interpretation to be taken into account in prevention communication. It is a delicate phase that is not attributable only to the visibility of the issue or problem, but also to the ability and symbolic resources that individuals possess. These are not distributed evenly within the population nor do they reproduce the same social and territorial family and economic contexts.

Next comes the problem of cultural inequalities at stake (Bentivegna, 2009), a problem which, along with that of social inequalities, has been too often overlooked or relegated to the margins of reflection in recent times. If I do not have sufficient or adequate cultural and symbolic resource perception, the significance and the selection will be strongly affected, and in some cases, severely limit the opportunities that could be seized. For example, it is known that good nutrition prevents serious health problems. However, it is also known that those who have greater economic and cultural deprivation tend to underestimate the problem, and thus poor nutrition adds further problems to those already in existence.

2.2. Knowledge.

This aspect is closely linked to the second phase of the process of change, knowledge. The transition from the perception of the theme’s relevance to knowledge is primarily a growth of awareness of the need to deepen, individually or collectively, a certain aspect in which I am / we are concerned.

In this case as well the path is not deterministic but connected to both the characteristics and individual resources that are available across all media and interpersonal relationships. Neither aspect can be taken for granted; on the contrary, both aspects possess considerable difficulties, even when everything else would tell us otherwise. A striking example is the knowledge that should result from communication processes in risk or crisis situations due to natural disasters. Even in those moments which are critical for physical survival, the initial problematization does not automatically switch to the knowledge of what should be done (Horsley, 2016). Despite seismic risk awareness, few of us remember that there are small things you can do in your own home prior to a seismic event, such as securing everything hanging on the walls. Those involved in risk communication and prevention have tried to come up with and plan complex models that provide a strong activation of local communities and a strong involvement of people who could potentially be interested in such knowledge, with particular reference to those in the most vulnerable social situations (Volterrani, 2016). For example, the involvement of people with disabilities should not exist only "on paper" but actually stem from a detailed one-to-one relationship that increases the degree of risk knowledge and the consequent ability to implement what is necessary in order to prevent their problems.

2.3. Incorporation.

Knowledge alone, however, is not sufficient to prompt a possible action. The next step is incorporation. Some scholars of cognitive psychology (Hofstadter, Sander 2015; Sloman, Fernbach, 2017) have highlighted the way in which humans expand their wealth of concepts and terms in their own world of thought. The tool we use to categorize the outside world is the analogy, i.e., reading the external environment with the categories we already have in our heads and in our daily life experience. The incorporation of new concepts and new experiences is through comparisons – comparisons (note similarities) with what we have in our heads and what we think comes closest to the new issue we are facing. It is evident that absolute novelty will have more difficulty of being incorporated than new minor or simple variations on already known themes and problems. For those not raised in Italy, the bidet is an object and a concept which is not easy to incorporate (or even to comprehend), but it is easier than trying to imagine what it is like for a person without economic resources to make a sea crossing in the hold of a jampacked boat always on the verge of sinking. This is perhaps the most important aspect of the change through communication process because it leaves little room for innovation and far-reaching trends. We tend to consolidate what we know well and distrust what we do not know. No wonder this reasoning as the survival of the species is closely linked to the ability to read and assess the dangers posed by the unknown. The archetype of fear of the new and different is rooted in our collective imagination and is an integral part of human history (Durand, 1960). This does not mean that we do not possess the cultural tools to overcome this archetype, but, returning to the reflections on cultural inequalities, it is unthinkable that we all possess the same means. It is much easier to shrug our shoulders and say, "We've always done well" or "There is nothing to do; it’s fate" than evaluate alternatives and possibilities, and build visions and different horizons (Vergani, 2012) on the subject or the problem to be addressed.

2.4. Change.

The fourth and final phase is the action of change. This is a delicate phase because the action of change may have effects on both the individual and collective level and can be real or imaginary. Individual change is more complex because it involves a "revolution" in the behavior or attitudes of our daily lives. If we think of how challenging it is, for example, for individual smokers to quit smoking despite a large presence of information and empirical evidence, we can understand that this step, which is often considered to be "simple," possesses, however, many elements of complexity to be explored. The most common expression is, "I want to stop smoking because it’s bad for me, but I can’t." Another issue is the change of the collective imagination which, though complex, can be achieved more easily. In fact, this is closely connected with local cultural change or the collective imagination on the subject. Returning to the example of smoking, the growing prohibition of spaces available for smokers has been accepted as a positive change, even by smokers themselves, without protest.

The process of change can be connected to prevention communication and, therefore, is complex and articulated. If we add to the difficulties of interpersonal and media communication processes that are now an integral part of the studies on the audience (Murray et al, 2003; Bentivegna, Boccia Artieri, 2019), we understand that the challenge is difficult but very attractive to those who care about improving the quality of life of our communities.

3. The problem / opportunities of the mainstream

Reasoning on the change in the communication process means, therefore, trying to operate in order to push the public imagination in the direction of an enlargement of the symbolic resources available to individuals and communities of often complex and contradictory issues and problems, such as social ones. Opening the imaginary means making the images, ideas, and values that would otherwise remain marginal in our heads available and accessible to most people.

The mainstream is defined as the media cultural production (cinema, television series and serials, video games, and communications products) hegemonic in contemporary societies; namely, that set of behaviors, attitudes, and meanings to which we refer, even unknowingly (Martel, 2010), and which remain in our collective imagination so as to occupy almost all of the space, especially if we pause to assess the large overlap with common sense in contemporary society. Many features of contemporary common sense are produced by the mainstream media, which feed and reinforce ways of speaking and thinking – lifestyles. This is not to make a generic accusation of superficiality and banality in the mainstream but, rather, to highlight the potential role it plays in people's lives. Socialization, first of all, against those who have lifestyles, especially consumers in the western world. Anticipation of what the future might be, or rather the idea of the individual and collective future. It is an imaginary reserve from which drawing inspiration for the construction of identity (Silverstone, 1994). It is evident that prevention communication, as we have described it up to now, cannot remain on the periphery of the mainstream, cannot build a symbolic universe apart, but must instead promote a real colonization using homogeneous technical and quality standards and which is likely to contaminate and replace, symbolically and culturally, the mainstream. A positive example of the process of change in the mainstream is that of the perception of the care of the environment as a determinant for overall well-being (Peruzzi, Volterrani 2016, p. 150). Despite the fact that the conduct is not always consistent, ecological awareness has reached the heart of the mainstream within the last thirty years. The same reasoning cannot be said of the rampant issue of child poverty in African countries where the awareness has not turned into incorporation, or even produced the "stolen letter effect;" that is, objects that are right in front of everyone's eyes but go unnoticed.

Precisely for this reason it is even more necessary to share this vision of prevention communication in a cultural context which is often used to thinking that the important issues are very different.

All of this is adversely affected if we design prevention communication with a completely different approach from the other types of communication: participation.

4. Participatory prevention communication: an essential prerequisite

Prevention communication cannot exist without the participation of the holders of the problem, the interests of users, and the producers of communication. A triangle that is crucial if we want to trigger at least the start of the change processes we mentioned. If you want to increase blood donation among young people, it is not enough just to construct communications campaigns aimed at them, but also to construct occasions where the young people themselves are the protagonists.

Engagement is not just an observation of a different use of the media by the public, but one of the roads that promotes awareness and involvement of the citizens of a community (Dahlgren, 2009; 2013). And it is the first step before moving on to the knowledge, incorporation, and action for change.

Participation requires its own time and its own rules (Curran, 2011) to give space to all those who intend to take action. However, in prevention communication that does not mean slowing down but enriching and articulating content and mode of use.

Working on participatory prevention communication, starting from the construction and sharing of social representations and social imaginary, is a pretty unique perspective.

The process planning social-imaginary and social-engineering-communication of social representations, in fact, does not stop at the first change of the imaginary and social representations but continues if the contributions of groups of people and the points of view are activated and implemented in a systematic way. The result is a communicative planning that not only endures but is also able to constantly renew itself, thereby increasing the participation and involvement of new groups of people.

The multiplication of participating groups has a positive effect on local communities. It is the participation in prevention communication projects that changes perceptions and actions, and therefore, also semantic maps. For example, if I want to change young people's relationship with alcohol, I have to try to rebuild their perceptions and their imaginary, submit them, and be ready to change them again in order to understand where to direct the communication and, especially, how to build it in the first place. You redraw the conceptual boundaries of some issues, along with other social or individual identities not based on simple content but on a responsible involvement in the community or territory. It is a way of enhancing those roots within the vital world and common sense, of being in the world of everyday life that characterizes at least a part of civil society and the third sector.

5. New prevention communication strategies

If this is a plausible picture, what could the new communication strategies for organizations (public and nonprofit) interested in the change of social imaginary be? See figure 2.

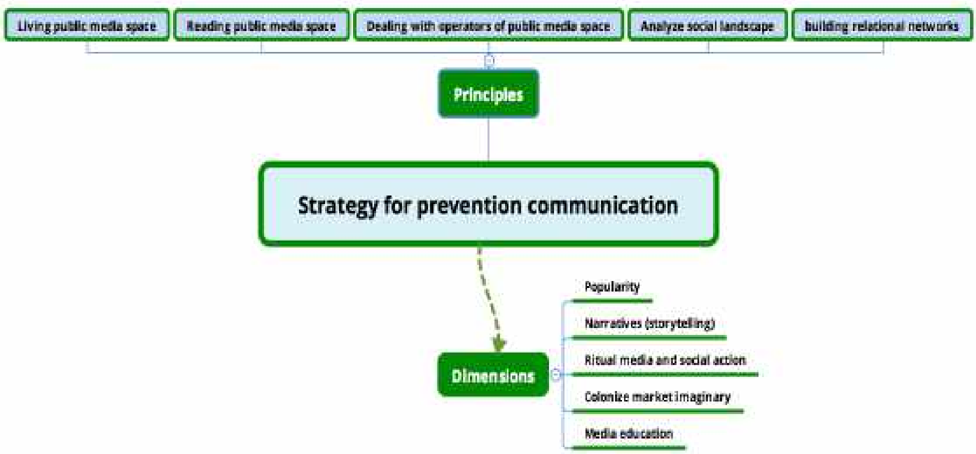

Figure 2 - *Strategy for prevention communication.*

5.1. Four principles

The first principle is monitoring the media public space daily – not only journalists, but also television (national and local) and the Internet – in order to be able to appropriate the narrative styles, symbology, and prevalent proposals from major manufacturers of the imaginary. Mastering the mainstream is essential in order to build a prevention communication that goes beyond.

The second principle is reading the media public space concerning social themes with detachment in order to highlight not only contradictions and shortcomings, but also symbols and rituals. Sometimes, some people talk about the absence of social and prevention issues without assessing their presence in narratives and imaginary places, such as the television series, which are rarely visited by organizations (public and nonprofit) but often frequented by individuals and communities (Buonanno, 2008). A key prerequisite for any prevention communication project is the rebuilding of the media outlets with the topic of our interest.

The third principle is dealing with the operators of media public space (journalists, producers, writers, and directors) in order to understand dynamics, languages, styles, and working routines, especially with regard to the production of TV series and serials. It becomes a credible interlocutor when there is a need, for example, to construct new narratives by television writers. There are no permanent confrontation areas, and if there is a change in media narratives, it is related more to a transformation of the authors, writers, and scriptwriters than to an initiative taken by organizations.

The fourth principle is analyzing and continuously monitoring the issue which is our membership organization's subject of interest, and then to go and explore different points of view removed from it, to see and learn the ways in which others learn the imagery of the subject that interests us. We will be surprised by how the social imaginary also extends to those who are most distant from those other individuals who are fully involved in communication actions on the subject.

5.2. Five aspects of a prevention communication strategy

Based on these principles, how can we build a sensible strategy in prevention?

There are five dimensions to be considered as cornerstones. We must inspire communication actions to popularity, which can be achieved if we put ourselves in the shoes of others (even when we do not like or agree with them) and attempt to share their thoughts and their imaginations.

1) Putting yourself in the shoes of others. Put yourself in the "shoes" of the means of understanding the mechanisms, styles, languages, and popular

places in the media public space. Of course, you may think this means, for example, speaking to those who care about their own issue (the issue that directly affects them), e.g., people with disabilities caring about other people with disabilities or the operators who deal with disabilities. They are important information and communication functions, but if I want to implement a process of change, I must listen to those who are furthest away from disability and who may not even want to hear about the topic. You may miss something, even then, in the richness and articulation of contents to acquire breadth (and depth) of communicative action. We must not forget that rooted popular stereotypes are not very rich or articulated in terms of information, but they are widely present in the mainstream and often correct with regard to prevention issues. Building popular prevention communication does not mean trivialization and simplification of the messages and content, but that messages and contents can be decoded and interpreted by many.

2) Looking for narratives. Narratives are the second important dimension of our strategy. Human life, history and biography, is our first story. The narrative approach (Bruno, Lombardinilo, 2016) to prevention communication means not only finding stories in the media, but developing the ability to discover, collect, and analyze stories, and then invent, build, and commission new ones, which then become representatives of the community. Stories must not appeal only to us, because the stories become narratives if we tell them to others and if others hear them. In addition, we must always keep in mind that there is only the "reality" or the "real" in the stories. The likelihood is that only one is possible and credible from among multiple realities (Schutz, 1972), and a story is deemed credible only if we share it with others. In summary, it is not important to build large, detailed stories, but instead to draw from the "mines of the stories" in social and prevention life, as well as from those that are already present in other corners of the collective imagination.

3) Rituals. The third dimension is the ritual. Our daily life is full of large and small rituals of which we do not want to do without. For example, the ritual that we follow when we get up in the morning that is difficult to differentiate or the way in which we tie our shoes. For this purpose, ritual also means proposing familiar actions and communication (Couldry, 2012, p. 80). The question we must ask is, "What creates meaning in my land and communicative context?" The question, though, is that very often what creates meaning is taken for granted and is silent since it works from a cultural background that determines common sense. The ritual dimension, by contrast, is a dimension that, behind the apparent static repetition of common sense,

can intervene in imagination, thereby modifying it. In practice, it means being systematically reproduced and easily identified by the inhabitants of a territory of prevention communication activities without fear of being repetitive because one of the goals is just that.

4) Colonize the collective imagination (Peruzzi, Volterrani, 2016, p. 220). The fourth dimension is that of colonization to which we referred earlier. The imaginary proposed by the actors who act in the market are not "evil" and, above all, make up the central part of the frame; they are the most widespread and popular, and also the most democratic. The profit actors are appropriate in a time of popular social imaginary, which used them to expand or build new market space. As a counterpoint, third sector organizations or public organizations could do the same, utilizing widespread and previously used imaginary as part of the market to promote new social imaginary. This does not mean the flattening of market strategies or transfer of prevailing cultural patterns in the market, but recognizing what are now standards in the archive of images and imaginary and making use of them by offering an intelligent and creative remix that can support different but contiguous perspectives.

5) Educate the media. Finally, the last dimension refers to media education (Buckingham, 2003). Despite the many paths of learning and spread of pedagogical aspirations of many of the social issues of most organizations, the potential of sharing common media education is not widely perceived, not only in the context of schools and young people, but also as one of the cornerstones of lifelong learning. It is through these medium- to long-term paths that people acquire the skills to understand, analyze, and individually and collectively build media culture, thereby helping to build cultures and innovative collective imagination.

6. The communication campaign, "I don’t take risks:” a best practice with some problems

“Terremoto–Io non Rischio” (“Earthquakes-I don’t take risks”) is a national-wide Italian campaign to reduce seismic risk first launched in 2011. The campaign is now in its eighth year in 230 Italian districts, most of them classified as Type 1 and 2 areas, which identify them as being at medium and high seismic risk. The campaign has been promoted by Civil Protection and A.N.P.A.S (acronym for “Association of National and Public Assistance”) in partnership with Ingv (National Institute of Geophysics and Volcanology) and ReLuis (a web group made up of various university laboratories of physical engineering). The campaign aims to sensitize the population to earthquakes by attempting to spread information about the correct procedures to follow during seismic risk situations. The promoters of the campaign, attempting to increase citizen awareness and therefore simplify the handling and acquisition of topics about earthquakes, have collaborated with properly trained volunteers. The campaign, "Terremoto–Io non Rischio," is carried out by groups of volunteers who, on specially organized days, perform activities designed to sensitize the citizens of their communities.

The campaign is based on the principle of widespread diffusion: every single inhabitant is informed about seismic risks. That person then undertakes the responsibility of informing his/her relatives, friends, and acquaintances, who in turn inform the people they know, thus creating a network of territorial relationships.

The campaign provided training for over 2,000 volunteers who then trained another 10,000 volunteers on various topics: the historical memory of areas; the seismic nature of areas; the dangerousness of areas and vulnerability of housing estates; the decrease of seismic risk; the role of the state and of the individual citizen in preventative action; how to communicate seismic danger, storytelling; and how to logistically manage the assigned town squares for the campaign.

If we compare the model with the campaign, we can observe some very interesting aspects. Firstly, with regard to perception, the actual presence in the town squares frequented by Italian citizens allows for the increase of the relevance of the theme through proximity and familiarity.

Secondly, with respect to knowledge, face-to-face interpersonal relationships allow for a thorough examination of the prevention theme.

Thirdly, the involvement of volunteers increases both the degree of trust and the sharing of language simplicity, thus favoring the incorporation of the prevention themes.

Finally, the number of citizens who have changed their behavior after the campaign has increased by 35%, an excellent result in a context such as the Italian one where little attention had formally been paid to prevention.

The campaign "I don't take risks," if subjected to the evaluation lens of the prevention communication model, shows opportunities and problems that are interesting to talk over and tune up further reflections on the prevention communication model. To begin our analysis, the very first consideration concerns the relationships with the four areas of the model.

Let us start with perception. Over the years the work of the campaign has broadened the range of territorial action by involving a larger number of voluntary associations and municipalities. In spite of this, one of the remaining problems is prompting the entire population to perceive the potential relevance of the issue (social prevention in regard to the most common natural disasters).

Referring to the whole population, improving the level of perception of the topic (and not of the campaign) is not easy, but “I don’t take risks” privileges the involvement and participation of volunteers rather than paying close attention to the ways used to reach those who are not “feeling” the theme, those who think that the theme does not concern them directly, those who do not come out of their homes because they have their own ways of making use of communication (interpersonal and media) that avoids direct socialization and multiplication of relationships (human, both real and virtual).

These are just some of the hypotheses as to the possible motivations for which perceptive actions are not activated by large segments of the population in spite of the fact that the campaign employs the presence of volunteers in the streets. In addition to these, further merely quantitative issues must be added that are mainly related to the fact that a national communication strategy was not designed and built to support the action of volunteers in the territory, if not through a website. Secondly, the communication tools used (the interpersonal relationship and the informative brochure) do not allow for switching effectively to the subsequent phases of the model: knowledge and incorporation.

As far as the knowledge area is concerned, the campaign relied on hot tools such as the report and on cold and static tools like the brochure and the informative website. The idea of giving life through the interpersonal relationship is certainly fundamental in order to be able to assess the cognitive deficiencies that can be noticed in the population. But in this case the differences in the level of education and basic cultural instruments for interpretation are crucial. The campaign does not confront the problem of differentiation and uses the same content for all. On the other hand, the question of the "popularity" of a message is one of the main principles of a good prevention campaign; however, if we do not seize the opportunity to develop differentiated in-depth analysis on a cultural and cognitive basis, it is likely that the relevance of the topic will remain only at a perceptive phase.

The incorporation of the campaign “I don’t take risks” is a crucial point to discuss: if the behaviors proposed by the campaign do not become obvious to those who have perceived and elaborated on the theme, there will not even be the conditions for a change in everyday reality. This step needs (and the campaign follows this principle) continuity and ritual activity repeated over time as a first step. If we want something to become more similar to archetypes, we first need a certain period of time for new ideas, new concepts, and new imaginaries to settle into the individual and collective imagination. From this point of view, the campaign lasts for too short a period every year for the involved population to have the time to think over later. Secondly, familiarity is fundamental; that is, concepts should be used that are related to behaviors which are not too counter-intuitive and are, above all, simple and easy to reproduce.

Additionally, the campaign promotes this aspect with the use of a simple and clear graphic that effectively symbolizes some behaviors. In the end, a short reference to imagery already known by the population.

In this case, domestic culture plays an important role. In fact, if in some local contexts the memory of natural disasters produces a collective imaginary predisposed to accept suggestions for prevention and in other contexts there is a mix of poor memory (because the last natural disaster occurred centuries earlier) and fatalism, the collective imagination is clearly in contrast with preventive behavior and attitudes. The homogeneous campaign throughout the national territory does not properly deal with this issue.

The last area of the model is change. The two levels of change (both real and in the collective imagination) can be reached in the long-term, especially in territorial communities where there is a low or no perception of risk. The campaign has come to the point (2011-2019) of being able to carry out an impact assessment on those communities involved in the initial phases with regard to the behaviors to be followed in case of an earthquake. This would also be a suggested way in which it would be possible to revise the entire proposed route up to now. Despite these reflections as far as the model of prevention communication is concerned, the campaign “I don’t take risks” is the first example in Europe which has the merit of having paid attention to social prevention and not just infrastructure prevention, addressing issues and problems for which no experience had been made before.

7. Conclusion

In conclusion, talking about prevention communication today means addressing the problem of cultural production.

In fact, the model is not only useful as communication for natural disasters, but for prevention communication in general. We have experimented, with good results, the model on a European project called “OLTRE,” whose aim is to prevent the radicalization of young, second-generation Italians of Islamic origin through an on-line communication campaign; however, we will discuss specifically the results of this research on another occasion.

Many organizations and experts have often underestimated the aspect of prevention communication because it has been deemed secondary to preventive or response action – an error which has been paid for dearly because, as we have seen, the space was occupied mainly by market culture. The available space is limited, and it will be difficult to act if approaches, prevention communication methods, and actions are not changed.

Precisely for this reason it is important to accept the challenge of innovation that lies in the ability to design prevention communication strategies which have the means to promote and legitimize the growing presence in the available media space through fascinating and diffusible products and credible narratives.

However, it is important to underline that in the era of deep mediatization (Couldry and Hepp, 2017: 24-50) which involves and deeply changes every aspect of our daily lives, prevention also passes and will pass more and more through digital communication. This aspect does not close but rather reinforces the need to integrate interpersonal relationships face to face with the actions of the digital world, without interruption.

This road will inevitably also lead to the use of the so-called Big Data which, while respecting citizens' privacy and democratic control (Couldry and Mejias, 2019), can considerably improve the first phase of the model, prevention, by better understanding which aspects need to be clarified and, consequently, communicated within the different territorial communities. Territorial relations and digital support platforms are, therefore, two of the directions to be explored in the near future (Volterrani, 2019).

The hope is that they do not remain only ideas, but instead become instruments of daily action in organizations that have social change at heart.

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References

Bentivegna, S., 2009, *Disuguaglianze digitali*, Laterza, Roma-Bari.

Bentivegna, S., Boccia Artieri, G. 2019, Le teorie delle comunicazioni di massa e la sfida digitale, Laterza, Roma-Bari.

Bruno, M., Lombardinilo, A., 2016, *Narrazioni dell'incertezza: società, media, letteratura*, FrancoAngeli, Milano.

Buchingham, D., 2003, *Media Education: Literacy, Learning and Contemporary Culture,* Polity Press, Cambridge.

Buonanno, M., 2008, *The Age of Television: Experiences and Theories*, Intellect Ltd, Bristol.

Couldry, N., Mejias, U., 2019, *The Costs of Connection: How Data Is Colonizing Human Life and Appropriating It for Capitalism*, Stanford University Press, Stanford.

Couldry, N., Hepp, A., 2017, *The mediated construction of reality*, Polity Press, Cambridge.

Couldry, N., 2012, *Media, Society, World: Social Theory and Digital Media Practice, Polity Press*, Cambridge.

Couldry, N., Livingstone S., Markham T., 2010, *Media Consumption and Public Engagement: Beyond the Presumption of Attention*, Palgrave Macmillan, New York.

Curran, J., 2011, *Media and Democracy*, Routledge, London.

Dahlgren, P., 2009, *Media and Political Engagement: Citizens, Communication and Democracy*, Cambridge University Press, Cambridge.

Dahlgren, P., 2013, *The Political Web: Media, Participation and Alternative Democracy*, Palgrave Macmillan, New York.

Durand, G., 1960, *Les Structures anthropologiques de l'imaginaire*, Allier, Grenoble.

Hofstadter, D., Sander, E., 2015, *Superfici ed essenze. L'analogia come cuore pulsante del pensiero*, Codice Edizioni, Torino.

Horsley, J.S., 2016, "Media framing of disaster". In: Schwarz A., Seeger M.W., Auer C. (Eds.), *The Handbook of International Crisis Communication Research*, Wiley and Sons, Chichester.

Jedloswki, P., 2008, "Immaginario e senso comune". In: Carmagnola F., Matera V. (Eds.), *Genealogie dell'immaginario*, Utet, Torino.

Institute for Strategic Dialogue, 2015, *Counter Narratives and Alternative Narratives. The role of counter- and alternative narratives in prevention of radicalization*, RAN (Radicalization Awareness Network).

Lotto, B. 2017, *Percezioni,* Bollati Boringhieri, Torino.

Martel, F., 2010, *Mainstream,* Flammarion, Paris.

Murray, C., Schroder, K., Drotner K., Kline S., 2003, *Researching Audiences: A Practical Guide to Methods in Media Audience Analysis*, Arnold Publications, London.

Peruzzi, G., Volterrani, A., 2016, *La comunicazione sociale*, Laterza, Roma-Bari.

Schutz, A., 1972, *Collected Papers I. The Problem of Social Reality*, Springer, London.

Schwarz, A., Seeger M. W., Auer C., 2016, *The Handbook of International Crisis Communication Research*, Wiley and Sons, Chichester.

Silverstone, R., 1994, *Television and Everyday Life*, Routledge, London.

Sloman, S., Fernbach, P. 2017, *The Knowledge Illusion. Why We Never Think Alone*, Penguin Publishing Group, London.

Vergani, E., 2012, *Costruire visioni*, Exorma Edizioni, Rome.

Volterrani ,A., 2011, Saturare l'immaginario, Exorma Edizioni, Rome.

Volterrani, A., 2016, "How to Build Prevention for the Elderly and Disabled before Natural Disasters? The Added Social Value of Voluntary Organizations in Europe", *Sociology and Anthropology* 4 (2): 92-98.

Volterrani, A. 2018, "Participation and Communication in the Time of Social Media: A Chimera or an Opportunity", *Sociology Study*, May 2018, Vol. 8, No. 5, 213-219, doi: 10.17265/2159-5526/2018.05.002

Volterrani, A., Iezzi D.F., Ceccherelli A., 2018, "Communication of a Natural Disaster. An Earthquake Case in Social Media and Online Newspapers", *Sociology Study*, June 2018, Vol. 8, No. 6, 257-266, doi: 10.17265/2159-5526/2018.06.001.

Volterrani, A. 2019, "Community Development and Communication: Preliminary Case Studies in Italy", *Sociology Study*, April 2019, Vol. 9, No. 4, 135-145

6. Geoscientists' voice in the media: framing Earth science in the aftermath of Emilia 2012 and Amatrice 2016 seismic crises

Andrea Cerase[1]

Abstract

In the aftermath of an earthquake, broadcast and traditional media play a crucial role, fulfilling complex social and psychological functions. Geo-scientists are sought by the media to provide scientific assessments of seismic phenomena as to explain both what is happened and what is yet to come, also suggesting ways to mitigate risk at individual and societal level.

The visibility of scientist and their ability to spread their voice across the media is a very important aspect of disaster narratives, as it provides an opportunity to disseminate and receive relevant messages about hazard, risk mitigation and resilience. The genuine appetite for scientific knowledge (Wein et al., 2010) stresses the role of journalistic mediation along the whole risk / science communication process, as it improves newsmedia credibility along with public's understanding of both seismic phenomena and related risks.

The here presented research considered the media coverage of scientific issues during the Emilia 2012 and Amatrice 2016 seismic crisis by the four most circulating Italian national newspapers within the 31 days following the first earthquake shock. The comparative analysis of the two seismic crises considered 288 news stories, being analysed through content analysis, an empirical methodology that allows analysing media messages as well as other types of communicative texts, in order to formulate statistical inferences on their explicit meaning (Neuendorf, 2002).

The analysis made emerge two relevant points. First, media coverage of geo-science follows the 'typical' life cycle of news. Most of the articles are indeed concentrated in the very first days, rapidly decreasing in the following days till to disappear at the end of the month. Second, the daily amount of

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news story is significantly defined by three variables: the maximum magnitude of aftershocks in the previous day, the number of days after the 'zero event' and the degree of controversy / conflict that arises from scientific evaluation of the ongoing phenomena.

Keywords: Media; Earthquakes; Science Communication; Geoscientists; news framing, agenda building.

1. Introduction

When a socio-natural disaster occurs, the media system as a whole is called upon to perform various relevant social functions, ranging from the dissemination of early warning messages to the creation of a public space for political debate about risk management and mitigation measures' sustainability (Cerase, 2018). After a disaster, broadcast and traditional media play a crucial role, fulfilling complex social and psychological functions, which can alternatively foster or hinder the return to normality of both exposed communities and society at large. In the immediate aftermath of a disaster the media system is asked to fulfill relevant and complex symbolic functions, providing a continuous flow of information on the ongoing situation, to foster social and behavioural change, to give emotional support, to recall experiences from past events and to provide causal explanations of current events (Stalling, 1990; Massey, 1995; Perez – Lugo, 2004).

Scholars from risk communication field have recognized that information (and of course misinformation) can both amplify and mitigate the consequences of physical events (Kasperson *et al*. 1988; Kasperson, Kasperson & Kasperson, 1996; Pidgeon, Kasperson, Slovic, 2003). According to an early definition issued by Barney Turner: "disaster equals energy plus misinformation" (Turner, 1978: 186). Hence, socio-natural disasters also represent an important test for scientists, policymakers as well as citizens to readdress and reorganise risk assessment and mitigation strategies. From the early stages of a disaster, the media provide a set of symbolic resources and an arena to *stage* the debate on risk mitigation, also making available opportunities for scientists to deliver scientific knowledge to a larger audience, enhancing public awareness about risks, suggesting adaptive behaviours to cope with disasters and encouraging a change of social and political factors that may worsen the outcome of disasters (Perry, Tierney, Lindell, 2001; Pantti, Wahl-Jorgensen, Cottle, 2012).

Communication responds to the primary need of bringing order into a disrupted / discontinued reality, fostering the creation of shared and consistent narrative structures to make sense of the ongoing events. However, information is neither self-evident nor neutral, and must be first organized within shared cognitive structures (narrative frames) to make a comprehensive sense of the event, to be used to define situations and to provide basic knowledge that may help people to take decisions in a very difficult and uncertain situation.

Seen from another perspective, notably the Social Representation Theory perspective (Moscovici, 1981; Moscovici, 1993; Joffe, 2003; Joffe, 2012), one can say that a disaster is nothing more than the concrete actualisation of a particular risk, whereby the pre-existing representations given in a certain culture suddenly become insufficient and inadequate to provide causal explanation of the ongoing events. In such a situation people need a rationale to re-adapt their worldviews and to address decisions that should be taken. The media play a prominent role in "translating" expert knowledge "from a more reified, scientific universe into lay thinking" (Joffe, 2003, p. 60).

Although profound changes occurred in the mediascape in recent decades that enhanced and strengthened online communication: in times of crisis, traditional broadcast media such as newspapers, television networks and radio station still continue to play a crucial role in re-organizing the mess of non-hierarchized information, inconsistent claims, rumours and misinformation that characterise the internet as realm of disorganised skepticism (Krimsky, 2007). Traditional media provide audience with some relevant points of reference to arrange information about events within a coherent and comprehensive framework, and they also underpinning effective mitigation action as well as a different understanding of future risks.

As a consequence, it is supposed that media may provide a kind of "seal of quality" for the information which are gathered, selected and conveyed to the public, also providing a well-recognized arena to foster public debate. Broadcast media such as television, newspapers and magazines are still today an essential resource for citizens to cope with disasters, responding to public demand for trusted, viable knowledge to ground interpretations of such complex and elusive events. Especially in the first days following a major earthquake, scientists are asked by the media to provide scientific assessments of seismic phenomena, to explain both what has happened and what is supposed to happen in the near future. Therefore, geo-scientists' visibility and voice across the media is destined to increase and become central in the narrative of disasters, and therefore the immediate aftermath of a disaster can provide an unprecedented window of opportunity to disseminate relevant messages about hazard, risk mitigation and resilience. As recalled by Anne Wein and hers colleagues, the urge to make sense of the event thus results in a genuine appetite for scientific knowledge (Wein et al. 2010), stressing the role of journalistic mediation along the whole risk / science communication process, as well as the ability of the media to provide the public with steady and authoritative point of references to anchor their understanding of disasters and related phenomena.

Despite the excessive optimism of some supporters of the digital revolution, traditional broadcast media still retains a strong power to decide the issues to be included in the public agenda along with the narrative frames through which they will be represented. Moreover, traditional media still continue to be used by the most educated sections of the population as complementary sources of information along with the Internet, while the they are practically the only source used by less educated people (Censis, 2019; Istat, 2019).

It follows then that traditional broadcast media have been everything but replaced by digital media, instead they have only changed their role within a broader process of digital convergence. The growing diffusion of computers, tablets and smartphones has enabled such a convergence process by which a number of cumbersome devices such as telephones, televisions, stereos, and cameras have been gradually incorporated into smaller portable devices. Any content may be digitalised and easily managed, copied and shared on different platforms and then incorporated into new daily communication practices, which involve users in different forms of communication also remediating traditional broadcast media into new forms of social usages (Bolter & Grusin, 1999; Jenkins, 2006).

Nevertheless, journalistic mediation continues to play a central role in responding to the diverse and important needs of the directly affected populations and the communities and societies in which they operate, providing information on the current situation as well as emotional support, promoting social exchange, evoking past experiences of similar situations and, above all, providing causal explanations of ongoing events.

The media are a relevant resource for citizens to cope with socio-natural disasters, as they represent a crucial resource to understand risks. As postulated by the theorists of the Social Amplification of Risk, the catastrophic event not only updates the risk, but it triggers a series of communication processes that do not only concern scientific and institutional communication, but must refer to any message conveyed by any source through any channel, without restrictions on the direction of flow or on the breadth of the audience involved, and also take into account messages conveyed involuntarily (Kasperson et al., 1988).

Since first researches on media coverage of earthquakes, evidence highlight that media portrayal of such events is everything but a mirrored reflection of physical "reality". Indeed, the amount of news stories, along with the frames selected by the media to arrange a representation of the event, depends not only on physical factors such as magnitude and (of course) number of casualties and injured people, but also depends on a variety of social factors, including the way media are likely to build "typical" news frames for different types of issues, which should be referred to the concept of *media logic* (Altheide & Snow 1979), by which media contents, and more in particular news stories, are "molded by a format logic" (*ibidem*: 201). The concept of media logic is widespread used in media literature to indicate the specific frame of reference of the production of media culture, and how it works as a way of seeing and interpreting social affairs, selecting and organizing raw material and packing it into predetermined formats (e.g. TV news, newspapers'' interviews and so on). Media logic works as a "grammar of media communication" envisaging particular ways to organize, present, and emphasize news content and styles (Mazzoleni, 2008).

Given this premise, literature on media coverage of earthquakes has shown that a number of factors can result in increased / lessened media coverage of earthquakes. Among the others, one may recall geographic location, cultural vicinity, economic and political relations between the country where earthquake occurred and the country of the media that covers it, the possibility to highlight a connection or an affinity between the community hit by the earthquake and the audience of the media, the power status of the source, the availability of neutral accounts of earthquake-related stories such as the involvement of Heads of states or other political personalities in DRR efforts (Gaddy & Tanjong, 1986; Singer et al. 1991; Koopmans & Vliegenthart, 2010; Jamieson & Van Belle, 2018). Unfortunately, the majority of these studies are concerned on the way American or Western media cover earthquake-related stories, and these do not consider the way Italian media focus on earthquakes occurred in Italy, with few exception. In recent years, Dominici published an extensive research on media coverage of the destructive 2009 Aquila Earthquake and of the disputed issue of responsibility / liability for damage and victims, using content analysis techniques. Interestingly, the author found that experts were called in question in almost one in four articles (24,12%): seismologist, geologist and technicians weighed for almost half (49,48%) of the whole articles involving experts' opinion (Dominici, 2010).

2. The research

An accurate analysis of media coverage of socio-natural disaster may support a better understanding of both social and political responses to the event, and may also provide a solid explanation of factors and circumstances that make scientists' opinions and advice newsworthy and salient, shedding light on the way scientific knowledge is communicated by the media in a crisis situation. In particular, it is worthwhile considering whether each catastrophic event should be understood as a case in itself or whether, on the contrary, research may find common aspects in the representation of similar events which occurred at different times. More significantly, the media works as a kind of "social glue", being able to share information and definitions of the events across geographic boundaries and different sub-groups within society at large. In essence, the media arrange both textual and visual content into consistent and robust narrative frames, that are crucial to enable people in interpreting and making sense of the whole event (Miles, Morse 2007: 366).

This research considered the media coverage of scientific issues during the Emilia 2012 and Amatrice 2016 seismic crises, to the extent they were covered by the four major Italian national newspapers within the 31 days following the first earthquake. The research considered 248 issues of these newspapers, and collected and processed data by using content analysis, an empirical methodology for analysing media messages as well as other types of communicative texts in order to formulate statistical inferences on their explicit meaning (Neuendorf, 2002). Such a comparative analysis of news media coverage of Emilia (2012) and Central Italy's earthquakes (2016) highlights the relationship between physical events and media representation of expert knowledge, and emphasizes key trends and some significant signs of change in the news frames which have been used to assess and communicate seismic risk.

Since disasters are potentially traumatic events which are experienced by a wide population within a limited time horizon, the media are likely to pay more attention in the acute phase of the event, with particular regard to the three early stages of the disaster cycle: normalcy tragically disrupted, people escaping and searching for help, and officials working to restore order and find causes (Houston et al., 2012 For these reasons we decided to consider the whole coverage of scientific issue in the four Italian major national dailies (*Repubblica, Corriere della Sera, La Stampa, Il Messaggero*), issued within one month (31 days) after the first shake, retrieving all the news stories containing scientific information about earthquakes, seismology, risk mitigation and seismic engineering. We analysed 248 issues, resulting in a total of 288 news stories that met at least one of the following criteria: 1) the content mainly focuses on scientific issues; 2) research institutions are cited; 3) scientists or experts are cited; 4) the news story refers to scientific articles or similar; 5) the story contains processed data, maps or scientific explanations (e.g. seismogenic processes).

On these premises we collected 150 news stories for the earthquake in Emilia and 139 for the earthquake of Central Italy. As shown in Tab. 1, there are some significant differences in the whole number of articles for each media outlet between the two considered events: along with a substantial reduction for Repubblica (-4,5%), data highlights a growth for il Messaggero (+ 4,6%) and La Stampa (+ 2,9%) while the percentage remains virtually unchanged for Il Corriere della Sera (-0,1%).

Table 1 - *Sample description - number of news stories and newspapers*

	Emilia		*Central Italy*	
Newspaper	N	V%	N	V%
La Repubblica	35	23,3	22	15,8
Il Corriere della Sera	40	26,7	37	26,6
La Stampa	42	28,0	43	30,9
Il Messaggero	33	22,0	37	26,6
Total	150	100,0	139	100,0

The selected research methodology is quantitative content analysis, which consists of accurate, precise, objective, reliable, repeatable and valid procedures to analyse media messages as well as other types of communicative texts in order to formulate valid inferences on their explicit meaning (Neuendorf, 2002).

Such a methodology "is a research technique for making replicable and valid inferences from data to their context" (Krippendorff, 1980: 21) and basically consists in a set of rules to draw such inference from contextual and text-based variable (Roberts, 1997: 283). This research technique provides that any news story can be split into a number of smaller units (attributes) that may refer to any relevant feature of the news content (e.g. length, position, number of columns occupied, number of news stories about the same topic, photos, captions and so on) which are then coded into variables and then analyzed trough statistic methods in order to explore frequency distributions, relations between variables and causal effects, thus making it possible to formulate and test particular research hypotheses.

A general hypothesis of this study concerns salience and frames. For the scope of this work salience is first and foremost defined in terms of attention (number of news stories on a specific issue or frame) and prominence, which refers to the positioning of a story within a media text to communicate its importance (Kiousis, 2004). To ensure a more effective measurement of prominence, we developed a normalized salience index NSI that measures the prominence of any single news-story and it is calculated as the product of relative positioning index (RPI) and the relative visibility index (RVI). The first one (RPI) provides an accurate measurement of the relative distance of the news story from the front page, while IVR measures the page visibility of the article based on its collocation within the page and on approximate calculation of the area occupied by the news story within newspaper sheets. In both cases indices span from 0 minimum value to 1 maximum value, which also allows to compare newspapers with different styles and overall number of pages. Such two indicators are found to be highly correlated in both two events (0,875 for Emilia EQ and 0,779 for Central Italy EQ), thus providing a convincing evidence that such indicators are actually measuring two distinct dimensions of the same concept.

3. Discussion

3.1. General features: similarities in the two events

The comparative analysis of news media coverage of Emilia (2012) and Central Italy's earthquakes (2016) highlights the relationship between physical events and the media representation of expert knowledge, and emphasizes key trends and some significant signs of change in the news frames used to assess and communicate seismic risk.

The newsworthiness of scientific advice cannot be taken for grant: the analysis made two important points emerged. First, media coverage of geo-science follows a ‘typical’ life cycle, broadly compatible with hype media theory (Vasterman, 2005). Most of the articles are indeed concentrated in the very first days or around single seismic events with larger magnitude. The overall number of news stories rapidly decreases in the following days, until it disappears at the end of the month. This results is consistent with other recent research literature (e.g. Dominici, 2010; Devès et al., 2019), whose authors complain for the ephemeral attention of the media toward socio-natural disaster, also recognizing a recurring way to frame earthquake.

Nevertheless we do not agree that decay in media attention might be interpreted as a media bias rather than an effect of aforementioned media logic. Within the public arena model, media are to be considered as a place to stage public discussion on a limited number of emerging social problems rather than being a showcase to display a billboard campaign. This model provides an ongoing competition between different topics to enter the media agenda and then a relatively short life of single news stories, as a result of a dynamic process of competition among the members of a very large 'population' of social problem claims that are staged in institutional arenas, which include the media and of course public opinion and politics and where only few problems can gain widespread attention at one time (Hilgartner and Bosk, 1988). Of course, scientists may keep the attention of the public opinion high on seismic risk related problems, but they can manage it for limited periods only.

Second, the daily amount of news stories is significantly defined by three variables: the maximum magnitude of aftershocks in the previous day, the number of days after the 'zero event' and the degree of controversy / conflict that arises from scientific evaluation of the ongoing phenomena. Along with substantive features of the event, the possibility to define an event in terms of a clash between opposing interest groups fits the needs of news storytelling, thus enhancing newsworthiness, since 'events can be cast into conflict stories with a more or less standard plot' (Gamson, 1985: 618).As trivial as it may appear, data show that EQ and other disasters are likely to trigger a sudden increase in the number of news stories until a point of saturation, followed by a slower decrease. In simpler words, data provide evidence of an inverse correlation between the number of news stories and the number of days that have passed since the first "big" shake, by which media attention decreases over time unless other disaster related events (such a funeral, a press release from authorities and first and foremost a bigger shake) prompts new attention thus increasing coverage again.

Evidence also suggest that the amount of news stories on a daily basis is significantly dependent on the physical events, and more precisely, it is found to be higher when stronger shakes interrupt the alleged linearity of return to "physical" normalcy. Data shows a strong correlation between the intensity of seismic activity (measured on a daily basis) and the amplitude of coverage in newspapers on the following day. The higher number of news stories about scientific issues is very likely to follow the maximum EQ magnitude recorded on the previous day (INGV - National Earthquakes Centre, 2016).

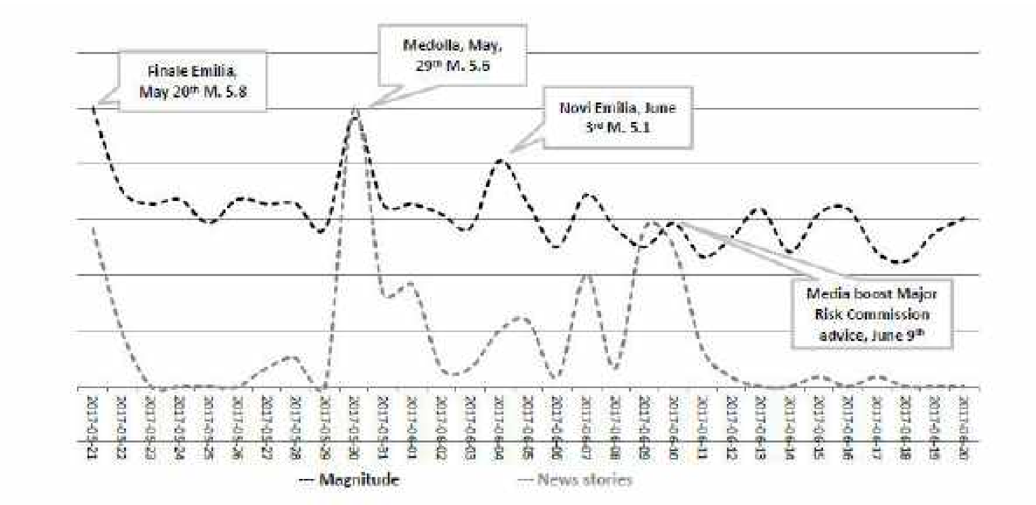
Nonetheless, coverage amplitude is not affected only by physical intensity of EQ but also by other "social factors", namely the conflict arising from controversial issues related to risk assessment and their implication on people's lives and the local economy.

For example, in 2012 the Major Risk Commission made a statement about the evolution of seismic sequence, thus suggesting a possible eastward migration of seismicity. Such an assessment triggered a huge wave of concern, outrage and other social reactions, revamping media attention on EQ science.

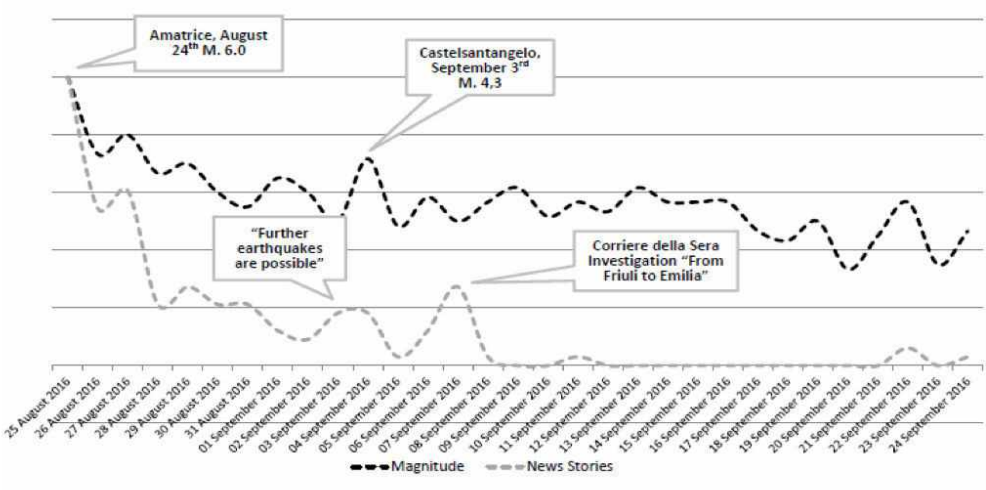
When available, images and infographic content are likely to increase both the salience and newsworthiness of scientific issues. The ability to provide graphic content discloses a "window of opportunity" to reach the general public and to improve their understanding of seismic phenomena and related risks. However, using infographics does not necessarily mean a trivialization or a popularization of scientific advice. In fact, given the limited space available in any newspaper page (limited time when it comes to television in relation to the overall time of any newscast), a graphic presentation of complex contents, such as the description of a fault system or the subduction between two continental plates, can provide a description of a multifaceted physical process in an eye-catching way, thus saving a lot of space to express the concept through text. To better substantiate this, our research provides some cases which deserve a closer qualitative discussion. As some stunning images from satellite interferometry about ground displacement occurred as a consequence of EQ were made available by Scientific Institutions and Space Agencies, they were given widespread and immediate visibility on other broadcast media such as television news and the homepages of online newspapers, which then led to them being taken up and spread by traditional newspapers, sometimes on the front-page.

For both earthquakes, data shows a strong correlation between the maximum magnitude recorded the previous day (INGV - National Earthquake Centre, 2016) and the number of news stories about scientific aspects of earthquakes. The scores of such correlation coefficients (σ Pearson) are respectively 0.597 for the Emilia seismic crisis and 0.847 for the Central Italy earthquake. Furthermore the overall number of news stories decreases over time and this tendency is described by a strong negative correlation between the number of articles and the days elapsed since the first earthquake. For Emilia the value σ is -0.563, while for Central Italy σ is -0.715. Although tautological, the frequency of the articles is directly proportional to the intensity of the shocks of the previous day and inversely proportional to the days passed. Nonetheless, such relations are not plainly linear: relevant discontinuities have been found when media decide to go in-depth through journalistic inquiries as well as when a controversial issue emerges and demands to be covered. The concern of citizens and authorities has intensified as a result of seismicity migration from central Emilia to the eastern provinces. The Major Risks Commission has sounded the alarm for the possible new earthquakes in the so-called "third fault segment" triggering a huge amount of reactions from scientists, officers and local administrators, the latter? worried about mitigation measures and possible economic impacts on economy and tourism.

The time series of seismicity and news coverage (graphs 1 and 2) highlights some relevant issues. In the aftermath of the Central Italy earthquake the highest number of scientific articles coincides with the strong initial shock, indeed 33 news stories were published on 25 August (see graph. 1). A little discontinuity – not due to seismicity – has been found on September 7th, when the Corriere della Sera published an extensive journalistic investigation on both impacts and legal implications of five major earthquakes, "from Friuli to Emilia".



Graph. 1 - *Emilia Earthquake: Magnitude and news stories over time.*



Graph. 2 - *Central Italy Earthquake: Magnitude and news stories over time.*

3.2. A closer comparison of differences between the two events

These two events have both points in common and important differences. The earthquake of Central Italy claimed more lives, more than ten times the one that occurred in Emilia-Romagna. Secondly, the overall magnitude of destruction, in terms of building and infrastructures which collapsed or were seriously damaged, was much higher than in Emilia-Romagna. Third, the first earthquake hit a relatively limited area, whereas the second one hit four different regions of Central Italy, with a lower density of industrial activities and thus led to less damage to the socio-economic fabric, which, from the very beginning, has made risk assessment and disaster recovery operations more complicated. Furthermore, a great deal of heterogeneity emerged in the damage suffered by households and buildings in municipalities that are relatively close to each other. Experts from applied seismology and seismic engineering were immediately called into question by the media, and they correctly framed such a difference as a consequence of the different quality in the built environment. In particular, until the second M 6.5 big shake of October 30th, that greatly exceeded the magnitude of August 24th event (and in any case is beyond the time interval considered by the research), the municipality of Norcia suffered less damage with respect to Amatrice, Accumoli e Arquata due to a wide refurbishing and consolidation plan that was carried out after a smaller earthquake in Norcia in 1979. Seen through a more qualitative lens, the increased role of scientists and experts (engineers and experts of hazard) literally forced newspapers to turn the narrative frame of “unexplained differences” into a powerful, long-lasting and pervasive narrative about resilience, encompassing the role of scientists, civil protection authorities, local authorities and government in a long term strategy to improve both building quality and mitigation measures.

Such differences also emerge from data, since data on news frames were collected for each single new story and for both two events. In other words, across the two events the voice of scientists is differently spent by the media to nurture different perspectives on the event per se and on risk mitigation strategy, as to cope with future similar events. Recalling Robert’s Entman popular definition we should recall that “to frame is to select some aspects of a perceived reality and make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation and/or treatment recommendation for the item described” (Entman, 1993: 52). Framing is therefore a particular way of defining and approaching a particular problem, and the media not only can throw a light on a particular issue rather than others, but also can provide a particular way to understand them and to act accordingly (Scheufele, 1999).

Nonetheless, the media are not the only social actor involved in frame building since it is influenced by the intrinsic logic of the newsmaking process (Altheide & Snow, 1979), and it is mediated by a number of factors such as social and professional norms and values, organizational constraints and routines, influences from interest groups together with ideological or political orientations of journalists themselves (Tuchman, 1978; Shoemaker & Reese,1996; Scheufele, 1999).

Furthermore, framing should not be intended as the way journalists spin a certain story to promote a particular vision of the problem in order to deceive their audiences. Framing should rather be seen as a necessary tool to present relatively complex issues – including advanced scientific research - to make them accessible to the general public given the journalists’ ability to play with existing cognitive schemas (Scheufele & Tewksbury, 2006).

To better understand narrative frames and whether and how they would have changed between the two events, we first provided a qualitative analysis of the emerging issues in order to provide a clear and effective categorization of the issues on which the media were soliciting scientists’ opinions as they emerged from news stories. We applied the thematic analysis (TA) which is a qualitative method widely used in social sciences for identifying and analysing recurring patterns of meaning within a given (textual) data set. Such patterns are defined as themes, and they may both refer to manifest or implicit contents (Joffe, 2012). Within the media research, the concept of thematic frame may refer to the way news stories are focused on information regarding some well-identifiable general trends which provide background or "takeout" stories within the whole coverage (Iyengar, 1990).

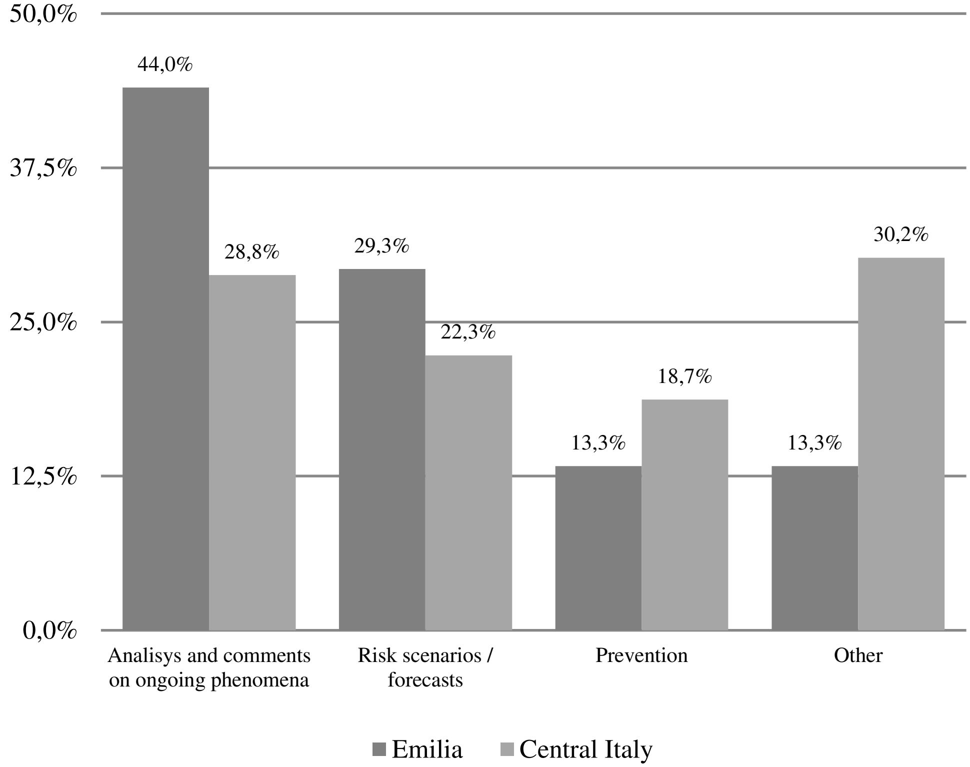
On the basis of these qualitative criteria, four distinct news frames were identified to describe the general ways in which scientific knowledge and expertise are related to some specific thematic issues. We have therefore developed a set of criteria to assign as homogeneously as possible to each of the news stories to one of the frames identified, with the aim of measuring their relative weight and check if there were any changes over time. The first concerns the analysis and evaluation of phenomena, i.e. the description and explanation of what had just happened or was happening in the hours or days immediately preceding. This category, among other things, included the analysis of seismogenic mechanisms, evaluations of the intensity of shakes or their localisations.

Risk scenarios instead refer to the possible future evolution of the phenomena themselves, such as the possible duration of the swarm, the phenomena of seismic migration that accompanied both earthquakes and the possible activation of the now famous third segment.

Prevention, on the other hand, refers to all activities aimed at risk reduction within a much broader time horizon, and includes sub-themes such as building codes, risk regulation, hazard assessment along with the debate on the policies to "secure" buildings, neighborhoods or entire areas exposed to seismic risk.

Inevitably, although the number of categories may be expanded, it is virtually impossible for all cases to be described in such a way, making it necessary to create a residual category "other". Although these data have only descriptive intents, in the dataset on the Central Italy Earthquake, the notion of historical seismology has been legitimated by the media as a way to assess hazard and explain in a more effective way ongoing phenomena, as it represents approximately 10% of scientific issue coverage providing a relevant matter of interest for both future research and science communication as well.

Such an analysis provides evidence of the changing role of scientists between the two considered events (see graph. 3). On the one hand, namely Emilia EQ, scientists were mainly asked to describe the events and their possible development on a short time perspective, as their role mainly consisted in providing diagnosis of the seismic crisis and possibly short time theories on its possible evolution. On the other hand, scientist got more space to talk about long time mitigation strategy along with other relevant scientific topics, such as historical seismology rather than results from up-to date research.



Graph. 3 - *Recurring themes in media coverage of Emilia and Central Italy EQs.*

The role of geoscientists including seismologists, geologists and physicists, deserves a closer examination. We first borrowed and readapted the marketing concept of "share of voice" in the analysis of the two different disasters. By "share of voice" we mean the percentage of news stories containing direct quotations of scientists in the overall number of articles considered. "Share of voice" should be intended as a direct measure of geoscientists' ability to address media debates on scientific aspects of earthquakes, as well as their ability to influence the way news stories are framed by the media. According to Iyengar (1991: 163), the presence or the absence of interviews with "talking heads" (e.g. scientist) is an essential diagnostic criterion to identify thematic reporting, as it complies with journalistic norms about objective journalism. Data show that the "share of voice" of geoscientists has substantially grown from 2011 to 2016, both in absolute values and percentages (tab. 2).

Table 2 - *Share of voice of geoscientists*

	Emilia		*Central Italy*	
	N	V%	N	V%
Yes	49	32,9	57	41,0
No	100	67,1	82	59,0
Total	149	100,0	139	100,0

More in detail, geoscientists are more likely to be cited when the main issue of the article is about diagnosis (analysis and comments on ongoing events) or prognosis (short-time forecast and risk scenarios).

Table 3 - *News stories citing geoscientists and thematic areas*

		Analysis and comments on ongoing phenomena		*Risk scenarios (forecast)*		*Prevention*		*Other*		*Total*
		N	V%	N	V%	N	V%	N	V%	
Emilia	No	48	72,7	19	43,2	15	75,0	19	95,0	101
	Yes	18	27,3	25	56,8	5	25,0	1	5,0	49
Total		66	100,0	44	100,0	20	100,0	20	100,0	150
Central Italy	No	14	35,0	17	54,8	23	88,5	28	66,7	82
	Yes	26	65,0	14	45,2	3	11,5	14	33,3	57
Total		40	100,0	31	100,0	26	100,0	42	100,0	139

Nevertheless, data highlight some relevant changes in variable distributions between the two events (*Tab.* 3), and in 2016 researchers from earth sciences were mainly sought out for short time analysis on ongoing phenomena, losing some ground in relation to the elicitation of risk scenarios and in addressing long-term prevention measures, where Earth scientists are basically replaced by engineers and risk managers[2].

Salience indicators highlight a puzzling change in the way scientists' opinion appears in newspapers. Although one may expect to see an increased role of scientists in the media, newspapers made different choices, as it emerges from the distribution of mean values of normalised salience index (NSI) of the news stories which were found to cite different kind of scientists and experts. Some interesting differences have been found between media salience of scientists in the two events under consideration: geoscientists' salience significantly decreased between Emilia and Central Italy events along with Risk Managers. Despite the growing relevance of prevention issues, engineers also lost something in terms of salience, while other scientists (including figures such as psychologists, social scientists and economists) registered a significant increase.

Tab. 4 - *Normalised salience index NSI: mean values in news stories citing different types of scientists.*

	Emilia Earthquake (2012)			*Central Italy Earthquake (2016)*		
	Mean	Std. Dev.	N	Mean	Std. Dev.	N
Geoscientists	0,3791	0,16784	49	0,2934	0,25006	57
Risk Managers	0,3885	0,24971	7	0,3082	0,25518	10
Engineers	0,3581	0,19079	16	0,3416	0,23139	31
Other scientists	0,3768	0,20719	8	0,4337	0,15139	10

4. Conclusions

Within a general hypothesis which provides that expert knowledge is used by the media to build a general representation of the disaster as well as a resource to cope with environmental uncertainty when earth systems disrupt

[2] Data showed that engineers were among the most prominent figures in the news coverage: during the Emilia earthquake, they were mentioned in 22.5% of articles, and this percentage increases up to 32.3% in the aftermath earthquake of Central Italy. Such a trend might be partially explained by the greater emphasis on prevention issues, which lead to a greater attention toward seismic and structural engineers.

the continuity of the recovery phase, it would be worth to see if geoscientists' visibility could be explained as an effect of endogenous factors rather than exogenous. We assume that endogenous factors are related to organizational needs of the newsmaking process (as recalled in media logic theory) while exogenous factors deal with the physical reality of the event, such as the maximum magnitude of earthquakes recorded in the day prior to publication, the occurrence of a big shake within some days along with the days elapsed since the first (big) event that triggered media attention, along with the fact that there were strong shocks in the previous three days (M=> Mw5). This is a theoretically relevant hypothesis that shows how the involvement of scientists stems more from the needs of news organizations to construct a satisfactory explanation of the disaster and to shore it up through the use of expert knowledge rather than depending only on the physical characteristics of the event itself (such as seismicity or the duration of the seismic crisis).

Media coverage of scientific issues tends to concentrate in the first days after the first main shock. Peaks in coverage (sudden rise of the number of news stories) appear to be closely related to three factors: A) physical intensity of the event (magnitude); B) loss of lives; C) social and political controversies arising from officials' evaluations and their supposed or expected impact on society and economics, as it happened during the Emilia crisis, when the Major Risk Commission's statement about possible seismicity migration triggered a little "news wave" about both risk and unintended consequences of such an evolution of the seismic crisis.

Relevant difference have been found in the way some scientific issues are discussed and presented, also affecting the role of single scientists and scientific institutions as legitimate holders of knowledge. Although scientists' role in general is shifting from the diagnosis of phenomena to that of expert advisor on mitigation policies, geoscientists are still asked to comment ongoing events and their possible short-time evolution.

Media should be seen as an arena, where different social actors are involved in a competition to get visibility and to stimulate responses by other social actors; indeed, a public exchange of statements and comments is likely to trigger both some reaction by other stakeholders and political controversies (Peters, 2007). As provided by the previously mentioned public arena model, different players engage in a competition to gain visibility and share of voice, and although individual scientists and scientific institutions still have a relevant role in media coverage of earthquakes, other players both from inside and outside scientific research are engaged in this vying for visibility.

Media interest for endogenous factors such as social conflict, perceived uncertainty and outrage must be considered both as a part and a consequence of the newsmaking process. However, the media strongly rely on certified knowledge from scientific institutions and scientists recognized and legitimated as fair, objective and trustworthy sources. In such a situation, scientists and scientific institutions can no longer exclusively rely on rent positions (reputation, fame and ability to influence academia) and they should improve their ability to both interact with the media and to "frame" political debate on future scenarios and mitigation measures that should be put in place. Between Emilia and Central Italy EQs significant changes occurred in the media portrayal of seismic phenomena and scientists' work, and in particular, there was a marked increase in the weight of prevention frame (news stories mainly focused on risk mitigation issues), encompassed by a stronger presence of scientists, government representatives, politicians and risk managers.

Scientists and scientific institutions have improved their ability to interact with the media as well as to "frame" political debate on future scenarios and mitigation measures that have to come. The role of scientists appears to be partially related to their scientific leadership per se and partly to their ability to dominate media logic. Along with providing accurate explanations and scientific advice, scientists should improve their ability to provide a continuous flow of data and graphical information, such as shake maps or satellite images. Their ability to meet with the needs of the media and to build / restore reputation and credibility would likely result in an improved effectiveness of their communication strategies.

References

Altheide, D., Snow, R., 1979, *Media logic*. Thousand Oaks: SAGE Publications.

Bolter, J. D. Grusin, R., 2000, *Remediation: Understanding New Media*. Cambridge, MA:The MIT Press.

Censis. 2018, *XV Rapporto sulla comunicazione. I media digitali e la fine dello star system*, Franco Angeli, Milano.

Cerase, A., 2018 "Re-assessing the role of communication in the aftermath of a disaster: case studies and lessons learned" in Antronico L., Marincioni F. (eds.), *Natural Hazards and Disaster Risk Reduction Policies*", Geographies of the Anthropocene book

Devès, M. H., Le Texier, M., Pécout, H., & Grasland, C., 2019,Seismic risk: the biases of earthquake media coverage *Geoscience Communication*, 2, pp. 125–141.

Dominici, P., 2010, *La società dell'irresponsabilità: L'Aquila, la carta stampata, i" nuovi" rischi, le scienze sociali*. FrancoAngeli, Milano.

Entman, R. M., 1993, Framing: Toward clarification of a fractured paradigm. *Journal of communication*, *43*(4), 51-58.

Gaddy G. D**,** Tanjong E**.,** 1986, Earthquake coverage by the western press. *Journal of Communication*, Vol. 36, (2), pp. 105–-112.

Gamson*, W. A., 1985. Goffman's legacy to political sociology. Theory and Society, 14(5), 605-622.*

Hilgartner, S., & Bosk, C. L., 1988. The rise and fall of social problems: A public arenas model. *American journal of Sociology,* 94(1), pp. 53-78.

Houston, J. B., Pfefferbaum, B., & Rosenholtz, C. E. 2012, "Disaster news: Framing and frame changing in coverage of major US natural disasters, 2000–2010". *Journalism & Mass Communication Quarterly*, *89*(4), 606-623.

INGV (2016) DataBase dell'Istituto Nazionale di Geofisica e Vulcanologia, Centro Nazionale Terremoti (http://cnt.rm.ingv.it/)

Istat, 2019, *Annuario statistico Italiano* 2018, Istat, Roma, 2018, https://www.istat.it/it/files//2018/12/C10.pdf

Iyengar, S., 1990, "Framing responsibility for political issues: The case of poverty". *Political behavior*, *12*(1), 19-40.

Iyengar, S., 1991. *Is Anyone Responsible?* Chicago: University of Chicago Press.

Jamieson, T., & Van Belle, D. A., 2018, Agenda setting, localisation and the third-person effect: an experimental study of when news content will directly influence public demands for policy change. *Political Science*, *70*(1), pp. 58-91.

Jenkins H., 2006, *Convergence Culture: Where Old and New Media Collide*, New York: New York University Press.

Joffe, H., 2003, "Risk: From perception to social representation", *British journal of Social Psychology 42*, 55–73

Joffe, H., 2012, "Thematic analysis". *Qualitative research methods in mental health and psychotherapy*, *1*.

Kasperson, R.E., Kasperson, J.X., 1996, *"The social amplification and attenuation of risk"*, in *The Annals of the American Academy of Political and Social Science*, 545 (1), pp. 95-105.

Kasperson, R.E., Renn O., Slovic, P., Brown, H.S., Emel, J., Goble, R., Kasperson, J.X., Ratick, S., 1988, "The social amplification of risk: A conceptual framework", *Risk Analysis*, 8 (2), pp. 177-187;

Kiousis, S. 2004, Explicating media salience: A factor analysis of New York Times issue coverage during the 2000 US presidential election. *Journal of Communication*, *54*(1), 71-87.

Koopmans, R., & Vliegenthart, R., 2010, Media attention as the outcome of a diffusion process - A theoretical framework and cross-national evidence on earthquake coverage. *European Sociological Review*, *27*(5), pp. 636-653.

Krimsky, S., 2007, "Risk communication in the internet age: The rise of disorganized skepticism", *Environmental hazards,* 7 (2), pp. 157-164.

Krippendorff, K., 1980. *Content Analysis. An Introduction to its Methodology.* Beverly Hills, CA: Sage.

Massey, K.B., 1995, "Analyzing the uses and gratifications concept of audience activity with a qualitative approach: Media encounters during the 1989 Loma Prieta earthquake disaster", *Journal of Broadcasting and Electronic Media,* 39 (3), pp. 328-349.

Mazzoleni, G. 2008, Media logic. In W. Donsbach (Ed.),The international encyclopedia of communication(pp. 2930–2932). Malden, MA: Blackwell, pp. 2930-2922.

Miles, B., Morse, S., 2007, "The role of news media in natural disaster risk and recovery", *Ecological Economics»*, 63 (2), pp. 365-373.

Moscovici, S., 1981. "On social representations" in *Social cognition: Perspectives on everyday understanding*, *8*(12), 181-209.

Moscovici, S., 1993, "Toward a social psychology of science". *Journal for the theory of social behaviour*, *23*(4), 343-374.

Neuendorf, K.A., 2002, *The content analysis guidebook*. London, Sage.

Pantti, M., Wahl-Jorgensen, K., Cottle, S., 2012, *Disasters and the Media*, New York, Peter Lang.

Perez-Lugo, M., 2004, "Media uses in disaster situations: A new focus on the impact phase", *Sociological inquiry*, 74 (2), pp. 210-225.

Perry, R.W., Lindell, M.K., Tierney, K.J., 2001, *Facing the unexpected: Disaster preparedness and response in the United States*, Washington, Joseph Henry Press.

Peters, H. P. (1994). Mass media as an information channel and public arena. *Risk*, *5*, 241.

Pidgeon, N., Kasperson, R.E., Slovic, P., 2003, *The social amplification of risk*, Cambridge, Cambridge University Press.

Roberts, C. 1997. *Text Analysis for the Social Sciences: Methods for Drawing Statistical Inferences from Texts and Transcripts*. Mahwah, NJ: Lawrence Erlbaum Associates, Publishers. pp. 275–285

Scheufele, D. A., & Tewksbury, D., 2006, “Framing, agenda setting, and priming: The evolution of three media effects models”. *Journal of communication*, *57*(1), 9-20.

Scheufele, D. A., 1999, “Framing as a theory of media effects”. *Journal of communication*, *49*(1), 103-122.

Shoemaker, P. J., & Reese, S. D., 1996, *Mediating the message*, Longman, White Plains.

Singer, E., Endreny, P., & Glassman, M. B.,1991, Media coverage of disasters: effect of geographic location. *Journalism Quarterly*, *68*(1-2), pp. 48-58..

Stallings, R.A., 1990, “Media discourse and the social construction of risk”, *Social problems*, 37 (1), pp. 80-95.

Tuchman, G., 1978, *Making news: A study in the construction of reality*, New York: Free Press.

Turner, B.A., 1978, *Man-made Disaster*, Wykeham Publications, London.

Vasterman, P.L.M., 2005, “Media-Hype: Self-Reinforcing News Waves, Journalistic Standards and the construction of social problems”, *European Journal of Communication*, 20 (4), pp. 508-530.

Wein, A., Potter, S., Johal, S., Doyle, E., Becker, J., 2015, “Communicating with the public during an earthquake sequence: Improving communication of geoscience by coordinating roles”, *Seismological Research Letters ,* 87, (1), pp. 1-7.

7. The 2016 Earthquake in Central Italy. The alphabet of reconstruction

Piero Farabollini[1]

Abstract

The proposed paper tries to take stock of the post sisma situation, three years after the central Italy earthquake, highlighting procedural problems and suggesting desirable improvements to the legislation governing reconstruction. The objective is to provide a complete scheme of the complex institutional process related to the problem of the post seismic reconstruction, by combining differents kind of informations: scientific, technical, regulatory and institutional.

The following pages aim at illustrating, through a sort of alphabet (where, however, some letters are missing, since the reconstruction path is not completed) the activity of the commissioner, the legislative and financial system and the route, with the relative rules to reach the objectives, necessary to give society the due guarantees. Such a great operation needs collaboration, sharing, intelligence, foresight and the will of everyone. And above all, it needs trust!

Keywords: Earthquakes, Society, Reconstruction, Commissioner, Communication

1. Introduction

On 24 August 2016, a magnitude 6.0 earthquake struck central Italy, with its epicenter located on the border between the regions of Lazio, Marche, Abruzzo and Umbria, near the built-up area of Accumoli (Rieti, Lazio). On 26 and 30 October 2016 and 18 January 2017, four major seismic events occurred again, respectively of 5.7M, 5.9M, 6.5M and 5.7M, which extended the area affected by the sequence seismic, which corresponds to about 2000

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km2. The geological data relating to the surface effects detected immediately after the seismic events, as well as the numerous geophysical data available (accelerometric data, radar interferometry and GPS), all agree in attributing the genesis of the 2016 seismic events to the faults system of Monte Vettore-Monte Bove, consisting of several segments of normal and / or transtensive faults, which extends for about 30 kilometers in the NO-SE direction.(Aringoli et al., 2016, 2018).

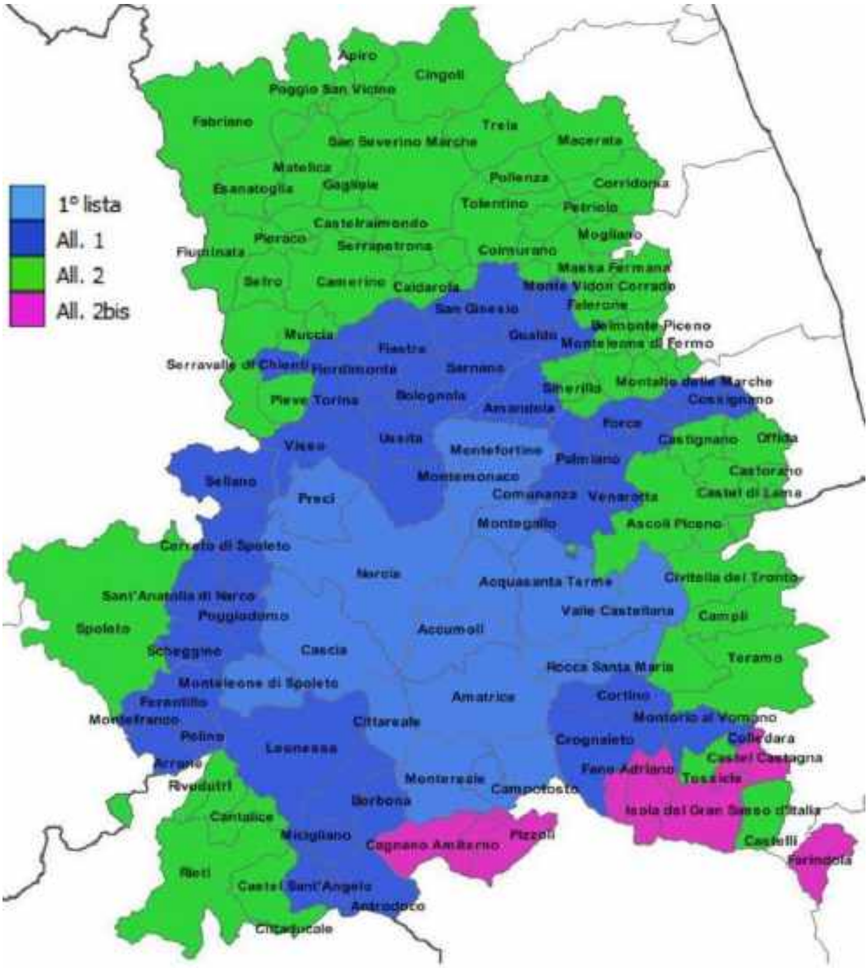
On 25 August 2016, the Council of Ministers, with its own resolution, declared a state of emergency, entrusting to the Civil Protection Department the coordination of the activities of this first emergency phase (which was managed by Di.Coma.C - Directorate for command and control, established in Rieti, with the Civil Protection Order dated August 26th) specifying that, at the end of the emergency phase, the Regions would ordinarily coordinate the interventions aimed to overcome this phase. In this way the Presidency of the Council of Ministers had specified that the management of the emergency phase was entrusted to the Department of Civil Protection, through the institution of the Di.Coma.C, that therefore was activated for the aspects of immediate support to the population and to the productive activities, while the management of the reconstruction phase was entrusted to a Special Government Commissioner, who was to provide for the implementation of the post-earthquake reconstruction phase (Valeriani & Bertelli, 2017). Subsequently, on 9 September 2016, after having recognized the complexity of the situation faced by the territories, the President of the Republic, by his own decree, appointed Vasco Errani (the former extraordinary commissioner for the Emilia earthquake 2012) as extraordinary commissioner of the Government for the reconstruction in the territories of the Municipalities of Abruzzo, Lazio, Marche and Umbria affected by the seismic event of 24 August 2016, and subsequently the Hon. Paola De Micheli (since September 2019 Minister for infrastructures). On 5 October the new government appointed Prof. Geol. Piero Farabollini as extraordinary commissioner for the reconstruction of the areas devastated by the 2016 earthquake.

It should be underlined how the extraordinary commissioner for post-earthquake reconstruction is in charge of reconstruction either, and therefore, only intervenes after the emergency phase. In this point of view, the structure of the Commissioner has no competences over what has already begun in the emergency phase, which passes through acts, actions, ordinances and proposed norms that instead fall within the competences of the National Civil Protection, until the emergency regime is in force, extended until 31 December 2019 (eg: SAE - Emergency Housing Solutions; CAS -

Autonomous Accommodation Contribution; Management of the Rubble Plan; etc.).

The content of this paper intends to explain a series of complex situation involving multiple subjects and refer to contexts in condition of continuous and often dramatic transformations. It is complex operation even the component description that concur to the characterization the action field of what is the management of post-seismic reconstruction. Combining informations of different nature is fundamental; scientific, technical, normative and institutional. To that end, was chosen to face up various themes using an “encyclopedic” approach, with a neo-illuministic soul. Maybe an unusual style for an article but certainly effective to clear up to the audience many realities not easy to understand. Even the bibliography is inserted as consulted, avoiding text references thanks to the approach followed in the setting.

The pages that follow want to illustrate, through a sort of alphabet (where, however, some letters are missing, being the reconstruction path not completed) the activity of the commissioner, the legislative and financial system and the route - with the relative rules to reach the objectives - necessary to give guarantees and trust, because a great operation like this needs collaboration, sharing, intelligence, foresight and the will of everyone. And above all of trust!



Da: Struttura Centrale del Commissario Straordinario https://sisma2016.gov.it/

Figure 1 – *Area and municipalities into the so called "seismic crater".*

2. Alphabet (uncompleted) of reconstruction

The seismic events of summer-autumn 2016 in central Italy, caused numerous victims and damages, showing once again the inability to effectively reduce the seismic risk in our country and associating these difficulties with problems relating to risk awareness by administrators and citizens, the availability of funds and engineering techniques suitable depending on the context in which they are applied (Cheema et al., 2016) (Valensise, 2018). The resulting need is a careful reflection on the different aspects that are important from a social and economic point of view of the cost of catastrophes (in particular of the seismic events which, as we know, are unpredictable, but which can be estimated in terms of maximum expected magnitude and hazard zoning): regulatory, scientific-technical and urban planning tools currently in use to prevent earthquakes, information and communication of danger and risk; resilience and cohabitation with natural dangers. If we want to avoid the same post seismic scenario in 2016 from happening again in the near future, we need to develop an advanced assessment of the seismic hazard, of coordinated emergency and post-emergency interventions and of the re-establishment of the social structure economic and cultural impact of the territory in order to guarantee the quality of the reconstruction and management of the geological security of the territory. It should be noted, however, that following the seismic events that began on 24 August 2016, a conscious and participatory moving of several thousand people from the areas of the so-called "crater" towards the coastal area. The result has been a gradual depopulation of mountain areas, which has already been underway for several years, which has resulted in a "forced exodus" (both to the need of avoid hazards, and to the emergencial instructions) especially with regard to those who would never have abandoned the mountain territory, due to the strong loyalty of the older people to native places. Currently we are witnessing an impoverishment of the population, especially the younger one, from the mountain areas, with consequent overcrowding of the destination areas that do not have the means, resources and ability to guarantee adequate services to the new, unexpected, unplanned demographic impulse.

A as: AeDes, FAST, sworn studies

After the first strong earthquake of 24 August, the usability checks, through the AeDes procedures (Suitability and Damage in seismic emergency, updated with the DPCM. 8 July 2014) and Fast (Italian acronym for Buildings for post-Earthquake Synthetic Compliance with safety standards), activated , the latter, after the seismic events of 26 and 30 October, with data provided by the Civil Protection department and compared with those provided by the USR (and updated to 31 December 2017), report 110,724 usability inspections carried out in Marche, Umbria, Lazio and Abruzzo, all central Italian regions. Out of 43,853 private buildings, 45% were fit for use, to which approximately 10% of buildings that are not damaged but are unusable due to external risk are added, while 35% was declared unfit for use and the remaining had partial or temporary results unavailability.

The checks (still) have not been completed, also because following the events of the end of October, the viability verification procedure has changed. In fact, in private reconstruction, the post-earthquake usability checks carried out through the AeDES board were carried out on those buildings that were declared unusable, following the so-called FAST verification aimed at selecting buildings available respect to those that could not be used immediately. The private individuals, therefore, owners of damaged buildings and in possession of the requisites necessary to request the contribution for reconstruction, must appoint the professionals to the compilation of the AeDES forms, on the basis of the results of the "fast" pprocedures so-called FAST. The professional who drafted the FAST form, cannot also complete the AeDES form for the same building.

B as: Beni Culturali (cultural heritage and churches)

As part of the "Church Program" (Ordinances 23 of 05/05/2017; Ordinance 32 of 22/06/2017; Ordinance No. 38 of 08/09/2017), the commissioner, the MiBAC (Cultural Heritage and Activities and Tourism), and the Dioceses activated themselves to restore the usability of an invaluable identity heritage. For central Apennines places of worship, from the typical “porziuncole” (old and small country churches) to the cathedrals, from the road icons to the abbeys, not only represent cultural roots, but certainly an important tool of economic recovery. To date, the budget for the actions of the commissioner is certainly positive: around 64% of the provided interventions by the ordinances have been approved or realized (ISTAT, 2016).

Table 1 – *Ordinances and interventions expected and approved.*

Ordinances	*Interventions*	
	expected	*approved*
Ord. 23 Securing	65	52
Ord. 32 Securing	95	64
Ord. 32 Securing (9 FEC + 2 municipal)	11	na
Ord. 38 first floor cultural heritage (Mibac single actuator)	100	57
Total	*271*	*173*

The churches related to Ordinance n. 38 are 100, for a total expected amount of € 170.600.000 and the actuator subject is, pursuant to the Ordinance itself (and the memorandum of understanding between the Extraordinary Commissioner, the MiBAC and the Italian Episcopal Conference), the MiBAC. Following the amendment to article 15 paragraph 3 of Legislative Decree 189/2016 made with the so-called Genoa Decree (D.L.109 / 2018 of 28 September 2018), the dioceses can currently act as actuator subjects. Through the so-called "Table of the Consulta", composed of representatives of the CEI, (Italian Episcopal Council) the MiBAC and the structure of the extraordinary Commissioner, the technical table was launched to support the regularity of the implementation of this activity, which provides for streamlined methods for the reconstruction of churches with amount of works less than € 600.000.

C as: <u>Citizens</u> (active participation of citizens to reconstruction)

Hand in hand with the extreme lacunae of exhaustive documentary sources with correct data and in real time, it is necessary to think about the commissioner structure as a sort of cultural mediator as well as reconstruction financier, which has the opportunity to cooperate and coordinate with stakeholders. Starting a less mediatic and more operational management of the relationships with the different actors of the reconstruction, rather than financial and media performances, obliges to normative interventions to turn towards the reconstruction on the spot rather than on the paper and on the social networks through the realization of a dense network of meetings and contacts aimed at strengthening the relationship between reconstruction and its stakeholders, primarily all mayors and representatives of the institutions in the territories, professional networks, productive activities, universities.

Organizing meetings with the representatives of all the earthquake-stricken citizens committees, is substantial and effective when it is possible to express not only one's own requests, but also the vision of the status quo and future prospects, so as to allow a precious confrontation not only from the human and dialectical point of view, but also technical. However, it should be underlined that there are those who (fortunately very few) have “preferred” to use their representation in a Committee (Ordinance No. 36 of 08/09/2017) to campaign and / or to make personal advertising by giving knowledge and skills that the other members do not recognize and, however, assuming roles, in accordance with the law, which do not belong to them and rising to the role of coordinator or else only for their own self-referential needs, sometimes confusing skills and roles that belong to the Government rather that to the Civil Protection or the Extraordinary Commissioner (CAS, SAE, urban free zone, small discrepancies, taxation, extension of the suspension of utilities, heavy paychecks, etc.). It is also inevitable to underline that in some (very rare)case, it happens, by people belonging to the Committees (Ordinance No,36 of the 09/08/2017)a sort of autonomous and improper acquisition of roles and competences, normally due to Government, the Civil ¼Protection or the Special Commissioner (CAS, SAE,urban free zone,small discrepancies, taxation,extension of the suspension of utilities,etc.), Unfortunately, this phenomenon occurs with recurrence (in our as in other countries) in the case of a vast and complex emergency situation. Obviously this aspect strongly altered the balance of a reconstruction that had (and always should) be characterized by speed, efficiency,neutrality and security, also from the point of view of adaptation to the return times of future seismic events

D as: <u>DURC</u> (Document of Regular Contribution Congruity)

Order 58, issued by the Special Commissioner for Reconstruction, provides for new legislation regarding transparency in post-earthquake reconstruction operations for professionals and businesses. The companies that have carried out the reconstruction interventions are asked, in addition to the that certifies the regular contributions (DURC on line), also the congruity DURC, or the document that is provided by the competent Cassa Edile and which proves the adequacy of the incidence of the workforce used by the company to carry out the work in relation to the amount of works to be performed or already performed. Document also envisaged in private reconstruction works that receive grants exceeding 50 thousand euros. When the project progress status and final status are presented, the cost and incidence of labor must be calculated based on the criteria indicated in Annex 2 of the Ordinance itself.

E as co-seismic Geological <u>Effect</u>

Immediately after the main event on 24 August 2016, in addition to the immediate starting of the Civil Protection activities, were carried out by numerous researchers of research institutes and state universities checks on the environmental effects of the earthquake, linked to the reactivation of the active tectonic elements as well as secondary effects related to the main shock.

The direct effects are related to the deformation of the soil at the fault, whose rift has generated the seismic event and the effects are limited to an area that is not very extensive and close to breaking. The secondary effects, resulting from the temporary passage of seismic waves, have also been recognized very far from the epicenters, and have caused a widespread presence of permanent effects on the earth's surface which, in relation to the length of the fault and the magnitude released by the event, have been evaluated in order of thousands of km2. More than 5000 evidences have been collected that have allowed to build a database on the effects of the earthquake distinguished,as already said, in direct effects and secondary effects: ground fractures, activation and reactivation of large landslides and DGPV (slope deep gravitational deformations), rock collapses and / or debris avalanches, avalanches, collapse of sinkholes, mud volcanoes and liquefaction phenomena, Barrage due to landslides, differential settlement, changes in the water regime of the springs and the flow of the rivers, cracks and / or fractures and / or deformations on road and network infrastructures, etc (Civico et al., 2018) (Farabollini et al., 2017) (Farabollini et al., 2018).

The analysis of the numerous evidences found in the area of the so-called "crater", has allowed us to estimate how about 70% of the effects found are attributable to fractures and co-seismic cracking; that 8% are due to landslides s.l. and to deformations, while about 20% to failure of road and network infrastructures and the remaining 2% to failure, variations in the water regime and other minor causes (EMERGEO, 2016).

In addition to the purely geostructural aspect, linked to seismogenic faults, it is necessary to take into consideration the geomorphological effect on the environment and on damage, trying to verify and above all quantify the role of some elements that characterize the central Apennine territory (and in particular the role played by large landslides in the state of quiescence or DGPV), in determining effects of local amplification both in bedrock and in continental Quaternary deposits. Thus, based on the effects on the ground and on the damage to the buildings, it would also be possible to effectively locate the epicenter areas, especially for those seismic zone defined only by historical data.

F as FAC (Active and Capable Fault)

Many historical earthquakes have had catastrophic effects (1693 in eastern Sicily, 1783 in Calabria, 1805 in Molise, 1908 in Messina, 1915 in Fucino, 1968 in Belice; 1980 in Irpinia, 1997-98 in Umbria and Marche, 2009 in L'Aquila) reaching Magnitude close to or above 7.

Paleoseismological studies have allowed us to characterize the faults responsible for many of these earthquakes, demonstrating that late Pleistocene-Holocene dislocations have affected many structures considered, in the past, completely inactive (Aringoli et al., 2016). For Active and Capable Fault (FAC) therefore means that fault for which there is evidence of repeated reactivation, with breaking of the topographic surface in the last 40,000 years (Olocene-upper part of the Upper Pleistocene) (Coltorti & Farabollini, 2002) (Pierantoni et al., 2013) (Tondi & Cello, 2003).

Generally, this definition refers to the main fault breaking plan. The earthquake of 24 August 2016, from the first INGV analysis based on only GPS stations active at the time of the earthquake, was generated by a fault more than 18 km long and inclined about 50 degrees, which it runs north-northwest-south-southeast and plunges towards west below the Apennines. The movement of this fault, caused an extension of the Apennine chain of about 3-4 centimeters between the Tyrrhenian and the Adriatic. The identification of active and capable faults, is almost always connected to the different scientific currents and problems which emerge in all international academies, and so subject to different interpretations, usually with drastic effects on the work quality as serious errors of evaluation of the real seismogenic potential. Through the studies of seismic microzonation level 3, using the Addresses and Criteria for the Seismic Microzonation (MS Working Group, 2008) (Aringoli et Alii 2018), the danger from surface faulting is treated through the identification of a zone of respect of 15 + 15 m in the case of active and capable fault, and of 75 + 75 m for an active and incapable fault. It follows that the legislation on post-earthquake reconstruction (DL 189/2016) and the extraordinary commissioner's ordinances (Ordinance 25, Ordinance 39 and Ordinance 46), govern the uses of the land in active and capable fault zones, both from the point from an urbanistic point of view, that from the point of view of the use classes of the manufactured articles.

I as a risk Information and communication

It is one of the most important issues, strategic and delicate, intended both as an awareness tool for the occurring events and for the knowledge of related problems (Calzolari, 2018; Lombardi, 2005). The geographic and geomorphological structure of Italian country requires - avoiding further delays - the start of new strategies, based on a complete, and scientifically valid knowledge. The divulgation is essential: the prevention is necessarily based on those cognitive processes that activate conscious knowledge in society, necessary to face - or even better avoid - emergency situations, thanks to a progressive development of virtuous practices. The experiences carried out up until now, have largely confirmed the social need for a correct information, and underlined as well the broad spectrum utility of those innovative initiatives that have been undertaken (Farabollini et al. 2014). The themes belonging to popular culture, revealed a great validity if used as vector of information: it is finally clear the fundamental function of structured scientific communication programs, addressing a broad and composite audience. New codes, agile dialogic systems, flexible rhythms and operational autonomy: these are the characteristics necessary to start new communication strategies aimed at reaching a social education towards risk prevention. This is the new challenge of the research world (finally integrating itself with the communication one): to introduce the public to the characteristics of our country, making people able to recognizing its quality and vulnerability, as well as the Italian landscape's resources and risks (Farabollini et al., 2018) (Lugeri et al., 2018). Not to be forgotten is the geological mapping, a territorial analysis tool that is extremely valid also in sharing knowledge, thanks to the new methods of representation through Geographical Information Systems, which allow an integrated use of information and images, at different degrees of complexity, comprehensible to different ranges of users, at different levels of complexity.

M as Macerie (Rubble)

With the order of the Head of Department n. 391 of 1st September 2016, the Regions are assigned, which can make use of municipalities aid, the collection, transport in temporary storage, the recovery or disposal of materials deriving from collapses and from demolition of unsafe buildings. In the rubble management process, the remains of assets of historical and cultural interest, are managed with a dedicated procedure, selected and separated at the origin according to the indications of the MIBAC (Ministry of Cultural Heritage and Activities and Tourism), thanks to the support of specialized civil protection volunteers. In the same way, the management of asbestos-containing material is specifically regulated.

According to the Ordinance of the National Civil Protection Department n. 495 of 4 January 2018: ".... omissis .... 100 million, from the resources of the Solidarity Fund of the European Union, are assigned, by way of anticipation, to the Regions affected by the seismic events mentioned in the introduction , in proportion to the total estimate of the rubble of the same, and converge into the respective special accounts in order to guarantee the continuation, without interruption, of the activities referred to in art. 28, paragraph 4 of law decree, 17 October 2016, n. 189, ... omissis ”.

With letter prot. 63079 of 5 November 2018, the National Civil Protection Department announced that the regulation dictated by the Implementation Regulation of the European Union Solidarity Fund (EUSF), provided the use of the financial contribution within 18 months from the date of payment of the contribution by the Commission, specifying that 6 May 2019 would be the deadline by which expenses must be paid to be considered eligible.

At present the Regions:

- they have not completed the removal of the rubble;
- they have not completed the use of the funds disbursed pursuant to ODPCN 495 of 04 January 2018, whose reporting must be made until 6 May at risk of losing the residual fund;
- they used different awarding procedures (in some cases also through direct assignment, also for amounts above the threshold for which a board question was asked);
- they used costs for removal not in line with ODPCN n.495 dated 4 January 2018.

Table 2 - *Rubble removal.*

Region	*Estimated Rubble (Tons)*	*Fund Redistribution ODPCN N.59 04.01.2018*	*% Funds*	*Average Cost(€) a Ton (ODPCN n.59)*	*Cost paid by the single region*	*Total real rubble*	*Rubble removed*	*Further needs (request Regions)*	*Report on 10.03.2019 (from DPCN)*
Abruzzo	160.000	6.037.528,52	6	37,71	91,20	106.337,67	45.780,48	3.660.557,7	4.189.821,28
Lazio	1.287.000	48.564.370,05	48	37,71	60,00	1.170.000,00	950.000,00	30.000.000,0	21.064.860,21
Marche	1.103.091	41.624.646,10	42	37,71	59,00	1.079.705,42	615.718,43	19.516.150,0	21.064.860,21
Umbria	100.000	3.773.455,33	4	37,71	66,00	153.000,00	100.000,00	6.600.000,00	2.383.205,97
Total	2.650.091	100.000.000,00						59.776.707,7	48.702.747,67

M as Sisma 2016 reconstruction <u>Model</u>

At the beginning of October 2018, more than two years after the first shock of the most devastating earthquake that Italy remembers after Irpinia, the balance of what has been done for reconstruction has been objectively less despite the huge resources available. Many technicians had repeatedly invited the commissioner to review a model of reconstruction whose functional inadequacy was already evident. In a first phase, it was decided to adopt the reconstruction model used in Emilia Romagna for the 2012 earthquake. But the territorial situation in the mountainous-hilly areas of the central Apennines, thick of historical villages, showed the clear need to take into account the different complex natural and cultural structures of the areas. Where historical monuments stood or a traditional agricultural landscape element were established, often in case of recovery a territorial enhancement purposes (widespread hotels or niche agribusiness companies), is not possible to move as in case of wide plains, dense of industrial sheds and terraced houses.

Only as an example of how the distance between the two models was substantial, is it to be noted that the wall masonry was not considered in the calculation of volumes, typical of most of the structures of this Apennine belt.

Such a model, maybe, would have succeeded, even with difficulty, in some way to bear fruit, if the restricted area of the first so-called seismic crater (an Italian way to define the spatial extent of the area damaged by the earthquake) result of the shocks of August 2016, had not spread out of proportion after the great shock in October 2016 and that of January 2017. To the four municipalities that initially formed the crater (Accumoli and Amatrice nel Lazio, Arquata del Tronto and Montegallo in the Marche), others 134 have been added between Abruzzo, Lazio, Marche, Umbria. An area that is not only vast, but so heterogeneous due to its physiographic, building-town planning, landscape and socio-economic characteristics, that it requires an immediate change of vision (Lanzini, 2018).

Unfortunately also the following phase seemed more interlocutory than decision-making and propositional and, although it led to the production of various ordinances, nevertheless left procedural doubts and, in some cases, even overlaps and ample faculties of interpretation of the same. The result is that the need to "speed up" the reconstruction, cannot be separated from the need to substantiate the strategic vision for a new and more profitable approach to the procedures and related processes not only by the Commissioner, but by the legislator himself.

Certainly the will (of the Government in office at the time of 2016 seismic events) of not wanting to pass, through the instrument of a "special law", led to the obligation to use ordinary regulatory instruments that often involved slowing down, overlapping and different interpretations on procedures used and usable in both public and private reconstruction, forcing the Commissioner to request regulatory action notwithstanding Legislative Decree 189/2016 through proposed amendments, a method that has never been addressed previously, although were obvious the symptoms of a cumbersome reconstruction and sometimes directed to follow up more "political" than strategic, therefore failing in the ask of giving concrete answers to citizenship. Furthermore, the willingness of previous governments not to want to differentiate the area affected by the seismic sequence that began on 24 August 2016 and continued with the additional earthquakes of 26 and 30 October 2016, from that of 18 January 2017, identifying two craters with differentiation of the degree of damage , entailed that the reconstruction in the 138 municipalities is carried out with homogeneous and coordinated criteria throughout the crater area, in accordance with Law Decree 189/2016.

At present, considering that in any case the ordinances take into account a single crater, it follows that dividing the crater into two or more areas on the basis of the different degree of damage, although methodologically appropriate would lead to further delays and inconveniences and discontinuities that cannot be justified.

M as <u>MZS</u> (Seismic Microzonation)

The seismic events that have affected central Italy from 24 August 2016, also due to such a vast extension of the phenomenon on the territory, have shown unequivocally how the degree of damage has been strongly conditioned by the geological features s.l. of the territory involved. The result was the need to operate in a systematic way through studies of seismic microzonation as a tool for the prevention and mitigation of seismic risk. Italy, in fact, is the only country in the world that, in ordinary time, plans and carries out seismic micro-zoning throughout the national territory, with specially regulated methods of execution, entrusting studies to professional technicians that share in all the Regions the same criteria and standard executions.

Seismic microzonation can be done according to three study levels, depending on the purpose of the studies and the complexity of local situations:

A- Seismic microzonation of level 1, in which the homogeneous areas are identified in seismic perspective, identifying the areas susceptible to local effects and the type of expected effects: a map is produced that distinguishes the zones in stable, stable zones with amplifications and unstable zones;

B- Seismic microzonation of levels 2 and 3, which allows to elaborate on the level of knowledge with respect to level 1 microzonation, associating to the homogeneous zones a numerical quantification of the amplification of seismic motion. The distinction between the two levels is linked to the possibility of adopting simplified assessments in non-complex geological situations (level 2), respect to the needs to carry out specific numerical analysis of local seismic response (level 3).

The different levels of seismic microzonation can be applied to territory planning and emergencies, and to be supportive to the planning of interventions on the artifacts.

M as MUDE

The MUDE (SINGLE DIGITAL MODEL for BUILDING-platform for monitoring the reconstruction) is the request service of contribution for reconstruction and contextual dispatch of the qualifying building permit title, management of the progress of the work and establishment of an informatic file courtesy of the requests and actions of intervention .The tool was born within Piemonte region and the Municipality of Turin as part of an innovation project financed with ministerial funds of the year 2009 Program ELISA (Local Authorities - System Innovation) of the Presidency of the Council, and which saw as promoters also Emilia-Romagna region, Umbria region, Municipality of Padua, Municipality of Rome, Municipality of Bologna and Municipality of Modena.

It is therefore an application with all the pros and cons of a mature platform: it is widely disseminated and known by professionals so as not to be a further criticality but at the same time it suffers the weight of a technology that requires expensive configurations in the computers of professional. Furthermore, the platform is born with a vocation to control the data already in the compilation phase so as to simplify the preliminary activities, something sometimes perceived by professionals as "difficult".

Through the DNS management panel the sub-domains have been set, all addressed to the same IP address, as follows:

- sisma2016.gov.it
- anagrafe.sisma2016.gov.it
- assistenza.sisma2016.gov.it

- intranet.sisma2016.gov.it
- oopp.sisma2016.gov.it
- professionals.sisma2016.gov.it
- scuola.sisma2016.gov.it

However, this platform, as already said, presents some critical issues which, for purely technical reason, appear to be less "convenient":

* it is only supported by Internet Explorer, a now obsolete browser because for years it has not been updated by Microsoft, which replaced it with its new Edge browser

* does not allow the correction or replacement of cards and documents quickly and effectively during the loading phase, forcing long and unsuccessful sessions even the most expert technicians, who have had to register a data loss in conjunction with the deadlines for the 2018 terms of submission in the course of the maintenance / adaptation procedure to the legislation activated by the CSI Piemonte supplier

* the USR (special reconstruction offices) acquire the documents on MUDE, but carry out the entire procedural process on their own platform (also specifically created as in the case of the Marche), with difficulties in dialogue between the two systems.

The commissioning structure therefore does not directly have access the complete data for process monitoring and, above all, has incomplete data that requires a long data cleaning job. Through the MUDE, the control over the workflow of private reconstruction and productive activities can only be carried out in a very small part, in some cases making it inadequate to carry out that action of monitoring the interventions provided for by the Legislative Decree 189/2016, making it necessary to start the development of integrative tools and procedures summarized by a flexible, integrable and easily questionable platform.

N as Centro-Italia Earthquake 2016 <u>Numbers</u>

Thousands of earthquakes in just over three months, four regions (Abruzzo, Umbria, Marche and Lazio) affected by a seismic sequence started on 24 August 2016 that devastated the countries along the border between the same regions. The experts count over 20 thousand events of magnitude equal to or greater than 3.

According to the experts of the National Research Council (CNR) and of the National Institute of Geophysics and Volcanology (INGV), the three main shocks (24 August 2016; 26 and 30 October 2016) have created significant ground deformations. In particular, at Accumoli the earth has dropped by 20 centimeters, in Castelsantangelo sul Nera 18 centimeters while in Norcia about 70 centimeters.

Excluding the 63-year-old from Tolentino who died of a heart attack, the three earthquakes in central Italy killed 298 people, all victims of the August 24 shock.

Civil protection has 17,000 people assisted, including: 4.700 left in their own country,

9.400 lodged in hotels along the Adriatic coast and Lake Trasimeno, 2.900 in accommodation facilities spread over the territory, 326 in tents.

The Ministry of Defense has sent 450 soldiers from the Safe Roads Operation to guard the homes of the displaced of the 62 municipalities involved.

Following the seismic events, more than 870 emergency housing solutions (SAE) were provided to the inhabitants of the countries most affected by the earthquake, including, for example, 181 in Accumoli, 459 in Amatrice, 68 in Norcia and 170 in Arquata del Tronto.

According to an estimate of the ANCI (National Association of Italian Municipalities), there are about 200 thousand buildings damaged or unusable in the areas of central Italy affected by the earthquake. The areas devastated by the earthquake have about 3,000 heavily compromised farms and about 50 damaged stables.

According to the analysis carried out in collaboration with the Ministry of Cultural Heritage and Tourism, damages to cultural heritage amounted to over 541 million euros (over five thousand reports received by the Ministry of Cultural Heritage for damage to the artistic heritage); more than 22 thousand works of art have been recovered and more than 15 thousand books, while archival assets exceed 5 thousand linear meters (http://www.beniculturali.it/mibac). Subsequently the earthquake in central Italy in 2016, the damage exceeds € 23 billion and € 530 million, of which € 12.9 billion refers to damages relating to private buildings and € 1.1 billion to public buildings. The estimate includes direct damages, both public and private (those that have caused the destruction of buildings, infrastructures, crops and even those that have affected industries and businesses, cultural heritage, energy distribution networks, of gas, water) and the eligible costs, incurred by the State to face the emergency (www.agi.it).

O as <u>Opere</u> Pubbliche (Public Works)

The first public works plan (Ord. 37/2017) includes 207 interventions (19 in Abruzzo, 49 in Lazio, 100 in the Marche and 39 in Umbria). The second public work plan (Ord. 56/2018) provides 631 interventions (51 in Abruzzo, 115 in Lazio, 320 in the Marche and 105 in Umbria). No reconstruction of public works has been started by the USR in addition to the one for the schools. For public buildings for residential purposes, a total of 256 interventions are required, of which 70 are approved as follows:

Table 3 – *Public works interventions*

Region	*N° Interventions requested*	*Amount admitted*	*N° approved interventions at 31.12.2018*	*Amount relative to approved interventions.*
Abruzzo	84	87.111.478,18	0	
Lazio	1	2.278.727,46	0	
Marche	159	82.780.533,73	61	€ 20.352.530,81
Umbria	12	8.652.318,14	9	€ 8.652.318,14
Total	256	180.823.057,5	70	€ 29.004.848,95

O as <u>Ordinances</u>

From the beginning, the subjective view of the approach to reconstruction with respect to the need to set a new modus operandi, perhaps bearing in mind important results achieved by previous post-earthquake reconstructions such as those of Friuli in 1976 or Umbria-Marche of 1997-1998, or more that of L'Aquila 2009.

The result was the awareness that the amount of procedures, in the light of the current legislation of which, in any case, is the Legislative Decree 189/2016 that the consequent Ordinances of the Extraordinary Commissioner had necessarily to take into account, were the greatest deterrent, in some cases even an alibi to the presentation of the applications for access to the contribution: the proposed amendment to the Government, regarding the increase of people to be dedicated to the Municipalities, based on rules dictated by the quality and quantity of the practices to be examined and processed by the Offices Municipal reconstruction, takes into account the wishes expressed by the Municipalities to be direct architects of private reconstruction, at least as far as minor damages are concerned.

At present, the Ordinances issued are 75 but the need to speed up, direct, complete the reconstruction, make it possible to hypothesize the issue of further Ordinances (new OOPP Public Works Plan; second plan of instability; implementation plans; etc.). As an example, we would like to recall here that the 2012 earthquake in Emilia-Romagna has seen the emanation of about 500 ordinances.

P as Plan Of Disses And Security Of The Territory

A first important step towards the geological safety of the territory was to compare the results of the perimeters that the individual municipalities have prepared for their territories, pursuant to Ordinances n. 39 of 08/09/2017 and n.46 of 10/01/2018, crossing them with the results of the third level seismic microzonation surveys carried out pursuant to Ordinance n. 24 of 15th May 2017 and overlaying them on the areas defined by the regional PAI (hydrogeological planning) and by the district authority of central Italy, that has recently updated them. A choice aimed at capitalizing on the investment in surveys that have highlighted pockets of worrying instability in areas considered strategic by the reconstruction model "where it was, as it was".

Another instrument of territorial planning was also the Plan of disruption, drafted pursuant to ordinance n. 64 of October 2018. Examining the available documentation it was possible to perceive that the integrated study of the data, having as its object precisely the so-called "plan disruptions", was only a pure and mere list of situations that have nothing to deal with the causation of the earthquake, forcing in-depth analysis and mandatory monitoring also for verifying the congruity of expenditure with measures aimed at limiting reconstruction in areas of danger and hydrogeological and seismic risk, so not compatible with a safe reconstruction and optimal management of available resources. Thanks to the residues of a virtuous management of resources, a further in-depth analysis has been prepared on some situations whose the perimeters, according to Ordinance 25, overlap with the so-called “unstable” areas defined by seismic microzonation studies according to Ordinance 24.

Amount allocated by the ordinances for microzonation:

€ 3.758.400.

Amount allocated by the ordinances for geological instability:

€ 30,000,000 for the year 2018.

€ 70.295.160 for the year 2019.

Thus, a series of interventions were identified both in areas characterized by the presence of "landslide areas" and of "active and capable faults" where, through a compatible methodology and correlated with the results of seismic microzonation studies of Level III, further investigate the geophysical nature in order to know the gravitational acceleration typical of the soils and to guarantee reconstruction in seismic safety, also in accordance with the new NTC 2018 and the implementation circular.

P as Professionals

As in any post-catastrophic reconstruction event, it is necessary to build the fundamentals for the involvement of those who will be involved in the design of the reconstruction interventions s.l. In this sense, it is necessary to start an intense work of contact and confrontation with the Technical Professions Network, aimed also at making professionals aware of a proactive approach to reconstruction (www.protezionecivile.gov.it).

The establishment of a Technical Professions Table, in the identification of guidelines and the resolution of the critical issues "in fieri" it must be framed in the perspective of the solution research to streamline the application of the reconstruction procedures, both it is public and private, in compliance with current legislation (Law 152/2006; L.50 / 2008; etc.) and Legislative Decree 189/2016 which governs, specifically, post-earthquake reconstruction (DPC 2018).

DURC of congruity; the identification of the 50% anticipation methods envisaged by the DL Genoa; methods for implementing Local Seismic Response studies; accumulation of offices; deposit and / or authorization for seismic purposes; reconstruction in PAI areas; they are all examples of how it is necessary to interact with the Technical Profession Network, in order to identify paths that, by guaranteeing quality and legality in the reconstruction, in any case allow bureaucratic slimming and safety.

R as Private Reconstruction

The management of private reconstruction and production activities is a SRO (Special Reconstruction Offices) responsibility and makes use of the MUDE platform as an interface with the technicians appointed by those affected by the seismic damage. Through MUDE the requests for contributions are presented, accompanied by the documents required. The USR acquire the individual databases and transfer them to their own dedicated platform to process them each according to their own operating methods established in full autonomy as required by the Legislative Decree 189/2016. At 31 December 2018 360 M € were granted for private reconstruction, with 2,744 concession decrees, of which 2,027 for reconstruction and 717 for temporary relocation. The scenario on the estimate of the damage remains, that of the data resulting from the 219,000 inspections carried out by the Civil Protection.

Table 4 – *Private reconstruction and production activities: damage estimate. By Civil Protection*

Private reconstruction and production activities: damage estimate					
inspections	*datasheet AEDES + GL AEDES*	*Datasheet FAST*	*Buildings*		
			% Viable	*% No usable*	*% to be reclassified*
219.000	80.437	138.000	44%	44%	12%

The situation emerged from the reading of the Mude data is a number of files submitted that is lower than the one that could be estimated with the estimate of the damage. Instead of the expected 96,000 applications (44% of buildings that cannot be used due to direct and / or induced unusability), just over 13,104 have been loaded which represent only 13.7% of the potential situation and which, to an extent equal to 83%, are related to minor.

Tables 5-6 – *Private reconstruction and production activities: type of damage and status of application at 31/12/2018.*

Private reconstruction and production activities: type of damage at 31/12/2018			
Region	*Severe housing damage ordinance 13*	*Severe damage to productive activities ordinance 13*	*Slight damage ordinances 4 and 8*
Abruzzo	961	201	5.972
Lazio	76	11	473
Marche	659	83	3.576
Umbria	94	30	968
Total	*1.790*	*325*	*10.989*

Private reconstruction and production activities: status of application at 31.12.2018					
Region	*Presentated*	*Completed*	*In elaboraton (CUP)*	*Under processing at USR*	*In compilation on Mude*
Abruzzo	1.164	11	40	1.113	384
Lazio	559	43	145	371	156
Marche	4.317	573	850	2.894	865
Umbria	1.048	136	229	683	239
Total	*7.088*	*763*	*1.264*	*5.061*	*1.644*

With regard to private reconstruction and minor damage, classified through the AeDes sheets such as B and C, it would be advisable to allow the Municipalities to be subjects of single commissioning and centralizing bodies. In this way, following a streamlining of the preliminary investigations on the presentation of documentation by the professionals for the pre-investigation phase, and following subsequent release by the USR of the operational level of damage, with a declaration of adequacy of the technical-economic framework (QTE) presented by the professional himself, the Municipality would find itself providing permission for quick building. It derive that following the release by the Civil Engineers of the seismic authorization, the professional could present the metric calculation with the release of the decree in definitely much more suitable times. The subsequent procurement phase, would be carried out by the Municipalities, which, if properly equipped with additional qualified technical personnel, will be able to guarantee a faster reconstruction allowing the citizens to regain possession of their houses.

The assumption of responsibility by the Municipalities, professionals and the ability to release authorizations from the USR staff, would guarantee the effectiveness of the measure. The quality assurance of the reconstruction is insured by the controls pursuant to the experimental agreement for the coordination of the institute activities of the "Italy anti-mafia earthquake prevention mission structure", with the extraordinary commissioner's structure for post-quake reconstruction 2016 and the Judicial Activity on the subject of reconstruction in the Marche. This protocol of agreement, stipulated on 1st March 2019 in Ancona in addition to the possibility of being extended to the entire “crater” area, is certainly a highly useful tool to guarantee the quality of reconstruction as well as the effectiveness of control and safety on construction sites, both them public or private.

S as <u>Schools</u>

The school plays a role of attractor of communities like the productive settlements, and a sustainable school represents the pivot of a territory unquestionably subjected to a process of progressive depopulation that was moreover evident already before the 2016 seismic events. Examination of data, relating to interventions on school buildings regulated by ordinances n.14, n.33, n.56 and n.67, suggests the interpretation of some ideas as they were dictated more by an approach to reconstruction preparatory to public and media consent rather than the result of careful strategic planning for the reconstruction of the communities. This is demonstrated by the adoption of interventions (that have undergone a revision in terms of both quantity and detection or location) on plexuses that do not appear to be characterized by corresponding seismic damage. With the order

n. 63 of 6 September 2018, the approval of the projects and the issue of decrees granting contributions for all public works is the responsibility of the Presidents of the Region. This includes 81 schools (15 in Abruzzo, 13 in Lazio, 34 in the Marche and 19 in Umbria. Total cost of the interventions: 231,038,692.30 euros.

Table 7 - Private reconstruction and production activities: status of application at 31.12.2018

Private reconstruction and production activities: status of application at 31.12.2018						
Region	*Presentated*	*Completed*	*In elaboration (CUP)*	*Under processing at USR*		*In compilation on Mude*
Abruzzo	1.164	11	40	1.113		384
Lazio	559	43	145	371		156
Marche	4.317	573	850	2.894		865
Umbria	1.048	136	229	683		239
Total	*7.088*	*763*	*1.264*	*5.061*		*1.644*

From the analysis of the data it's shown that about 34% of the interventions concern schools outside the crater.

Regarding Ordinance n. 14 of 16 January 2017, in charge of the extraordinary commissioner's structure, it's to be reported that the 21 schools planned, of which 18 financed by the commissioner, 1 in Abruzzo, 2 in Lazio, 11 in the Marche, 4 in Umbria and 3 from private donations, for an amount of over € 95 million, in most cases they can be used from September 2019. The schools are examples of how cooperation between the special commissioner and the actuator subjects is necessary, and how the procedural procedure can be speeded up without necessarily departing from the respect of the control rules (ANAC National Autority against Corruption and the Ministry of the Interior's Mission Structure, standards contributions, urban-artistic-landscape constraints). However, it is to be specified that in the face of an allocation of 103 million euros, to date only 11.5 million have been decreed, a sign that the works are far from being completed, even these schools are considered strategic enough to be the object of a specific issued, even before the last seismic event of 18 January 2017. One of the reasons for this criticality, would seem to be related to the fact to put the final level projects at tender base without any formal opinion: this meant that when the executive project was presented by the company, critical issues related to constraints, with denial of opinions by interested entities, and consequent increase in accumulated delays. Having the project presented to the winning bidder only after the assignment of the order means that, where a minimum problem arises, this not only forces the project to be revised with the consequent increase in costs, but it slows down the reconstruction at the moment in which it appears more concrete, exposing the commissioner structure also to legal actions. The recourse to the form of contract, which envisages the awarding of the executive design and execution of the works, called the integrated contract, already provided for in law n. 109/94 and confirmed in Legislative Decree no. 163/06, to the company awarded the contract, it seems therefore to have created several difficulties due to the need to place the final project, which constitutes the basis of the tender, and to acquire all the opinions only after the preparation of the executive project creating thus further delays.

W as <u>WEB</u>

The commissioner's website provides a public communication service towards all interested parties, to comply with regulatory obligations on administrative transparency, on the Commissioner's records and serves as a hub to all other platforms.

For the creation of the site a Content Management System (CMS) was used, distributed with an open source license (GPLv2) with no cost and therefore very widespread even in the public administration, called Wordpress (version 4.6.1) on which a customization was developed. Graphic layout consistent with the guidelines on the design of public administration websites. The service can be reached from the following URL https://sisma2016.gov.it

References

Aringoli, D., Bufalini, M., Farabollini, P., Giacopetti, M., Materazzi, M., Pambianchi, G. & Scalella, G., 2018, "Effetti geomorfologici e variazioni idrogeologiche indotti dai terremoti: esempi nell'area epicentrale della sequenza sismica 2016-2017 del centro Italia", *Geologia dell'Ambiente*, suppl. 1/2018, 239-248.

Aringoli, D., Farabollini,, P., Giacopetti M., Materazzi, M., Paggi, S., Pambianchi, G., Pierantoni, P.P., Pistolesi, E., Pitts, A. & Tondi, E., 2016, "The August 24th 2016 Accumoli earthquake: surface faulting and Deep-Seated Gravitational Slope Deformation (DSGSD) in the Monte Vettore area", *Annals of Geophysics*, 59(5), https://doi.org/10.4401/ag-7199.

Calzolari, L., 2018, "Come i media raccontano un'emergenza", *Geologia dell'Ambiente*, Suppl. 1/2018, 80-84.

Cheema, A.R., Mehomood, A. & Imran M., 2016, "Learning from the past: analysis of disaster management structures, policies and institutions in Pakistan", *Disaster Prevention Management*, 25, 4, 449-463.

Civico, R., Pucci S., Villani, F., Pizzimenti, L., De Martini, P.M., Nappi, R. & the Open EMERGEO Working Group, 2018, *"Surface ruptures following the 30 October 2016 Mw 6.5 Norcia earthquake, central Italy" Journal of Maps*, 14(2), 151-160, https://doi.org/10.1080/17445647.2018.1441756.

Coltorti, M. & Farabollini, P., 2002, "Quaternary evolution of the Castelluccio di Norcia Basin (Umbro-Marchean Apennine, Central Italy)", *Il Quaternario*, 8 (1): 149-166.

D.L. 189/2016 (GU Serie Generale n.294 del 17-12-2016) - *Interventi urgenti in favore delle popolazioni colpite dagli eventi sismici del 2016.*

D.L.109 / 2018 of 28 September 2018. Decreto Genova.

EMERGEO Working Group, 2016, "Coseismic effects of the 2016

Amatrice seismic sequence: First geological results”, *Ann. Geophys.*, 59(5).

Farabollini P., Angelini, S., Fazzini, M., Lugeri, F.R., Scalella, G. & GeomorphoLab, 2018, “La sequenza sismica dell’Italia centrale del 24 agosto e successive: contributi alla conoscenza e la banca dati degli effetti di superficie”, *Rend. Online Soc. Geol. It.*, Vol. 46, https://doi.org/10.3301/ROL.2018.45.

Farabollini, P., Aringoli, D., Materazzi, M., Pambianchi, G. & Scalella, G. 2017, *Large Landslides and Deep Seated Gravitational Slope Deformation triggered by the 2016-2017 central Italy seismic crisis: first evidences from the Mount Vettore-Mt Bove epicentral area*. Abs. Int. Workshop “From 1997 to 2016: Three destructive earthquakes along the central Apennine fault system, Italy”. July 19-22, 2017.

Farabollini, P., Lugeri, F.L. & Lugeri, N., 2018, “Humankind and Risk: a difficult history”. In: Antronico L. & Marincioni F. (Eds.), *Natural Hazards and Disaster Risk Reduction Policies*, Geographies of the Anthropocene book series, Il Sileno Edizioni, Rende, 88-103.

Farabollini, P., Lugeri, F.R., Aldighieri, B. & Amadio, V., 2014. *The role of Earth Science and Landscape approach in the ethic geology: communication and divulgation for the prevention and rediction of geological hazard*. IAEG Torino 2014 Proc., Engineering Geology for Society and Territory, vol. 7, Springer Int. Publ. (DOI: 10.1007/978-3-319-09303-1_22).

ISTAT, 2016. *Focus: Caratteristiche dei Territori colpiti dal sisma del 24 agosto 2016*. www.istat.it.

Lanzini, M., 2018, “Evoluzione delle normative sismiche in Italia dal punto di vista geologico”, *Geologia dell’Ambiente*, suppl. 1/2018, 107-112.

Lombardi M., 2005. *La comunicazione dei rischi naturali.* V&P ed., 230pp.

Lugeri,, F., Farabollini P., Amadio, V. & Greco, R., 2018, “Unconventional Approach for Prevention of Environmental and Related Social Risks: A Geoethic Mission”, *MDPI Geosciences*, vol. 8, ISSN: 2076-3263, doi: 10.3390/geosciences8020054.

Pierantoni, P., Deiana, G. & Galdenzi, S., 2013, “Stratigraphic and structural features of the Sibillini Mountains (Umbria-Marche Apennines, Italy)”, *Ital. J. Geosci.,* 132(3), 497-520.

Tondi, E. & Cello, G., 2003, “Spatiotemporal Evolution of the Central Apennines Fault System (Italy)”*, Journal of Geodynamics*, 36, 113-128.

Valensise, G., 2018, “La prevedibilità dei disastri sismici fra sismologia e storia”, *Geologia dell’Ambiente*, suppl. 1/2018, 24-30.

Valeriani, E. & Bertelli, A., 2017, *L'attività del Commissario Straordinario ed il futuro della ricostruzione del Centro Italia: una strategia sostenibile.* https://sisma2016.gov.it/

Websites

www.agi.it/cronaca/terremoto_centro_italia_i_numeri_del_sisma-1213113/news
accessed on 10.10.2018
www.beniculturali.it/mibac. accessed on 10.10.2018
www.protezionecivile.gov.it (a) FAQ "*Qualificazione e compiti dei liberi professionisti" raccolte sul sito del Commissario per la ricostruzione.* accessed on 10.10.2018
www.protezionecivile.gov.it (b) FAQ "*Sopralluoghi e verifiche di agibilità" raccolte sul sito del Dipartimento della Protezione Civile.* accessed on 10.10.2018
www.sisma2016.gov.it accessed on 10.10.2018
www.anagrafe.sisma2016.gov.it accessed on 10.10.2018
www.assistenza.sisma2016.gov.it accessed on 10.10.2018
www.intranet.sisma2016.gov.it accessed on 10.10.2018
www.oopp.sisma2016.gov.it accessed on 10.10.2018
www.professionals.sisma2016.gov.it accessed on 10.10.2018
www.scuola.sisma2016.gov.it accessed on 10.10.2018

8. Food management in disasters: the case study of the earthquakes of 24 august 2016 in Central Italy

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Abstract

Access to safe food in the aftermath of a disaster is pivotal to ensure the survival and well-being of victims and rescuers. This study investigates food management in the case of the earthquakes of 24 August 2016 in Central Italy, assessing survivors' ability to access food (food security) and the field kitchens practices to ensure hygiene and avoid food-borne disease outbreak (food safety). The study was carried out administering questionnaires one month after the events, to field kitchens users (population hit by the earthquake and volunteer workers) and operatives. Five field kitchens located in the municipalities of Accumoli and Amatrice, in the Lazio Region, and in the municipality of Arquata del Tronto in the Marche Region, were examined. Results suggest that the food quantity, quality and the waiting time at the dining area were overall satisfactory. Almost all interviewed population and volunteer workers declared easy access to proper and abundant meals. Field kitchens operatives claimed both access to fresh ingredients, in quantities far exceeding the needs of the served communities, and availability of the necessary resources (technical and human) to guarantee controlled and safe conditions during preparation and distribution of food. The results of this study are synthesized in a model describing the various aspects that need to be address in order to properly manage food services during a disaster.

Keywords: Food emergency management; Field kitchen; Earthquake disaster; Italy

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1. Introduction

After a disaster hits a certain area, besides providing temporary accommodation to the survivors, rescuers must arrange also for food assistance for the immediate aftermath and for the recovery periods. This particular kind of food management can be divided into three phases: (i) immediate; (ii) sustained; (iii) long-term (U.S. National Mass Care Strategy, 2015). The immediate phase includes the first 72-96 hours after the occurrence of the event. Here, the organizations responsible for dealing with the food emergency are activated and intervene using their own and available local resources, providing the food necessary to ensure survival, such as water, sandwiches, pre-packaged foods, etc. In the second phase, the sustained one, all the infrastructures necessary to provide an adequate nutritional response are set up. The goal is to prepare and distribute cooked meals, snacks and drinks to the population, using fixed or mobile field kitchens. Finally, in the long-term phase, the focus is to restore the utilities which allow the population to start preparing their own food independently.

There are international guidelines on emergency food management aimed to develop universal humanitarian intervention standards to support populations affected by disasters (e.g. Sphere Association, 2018). According to these guidelines, the two basic aspects to comply during a post-disaster food preparation and distribution are food safety and food security. The term “food safety” indicates the set of conditions that guarantee the good quality of food or drink, from a hygienic-sanitary point of view, during all stages of the food chain (FAO, 2006). The term "food security" indicates the set of conditions that ensure the availability of sufficient quantities of food to provide adequate nutrition (*ibid*).

There is abundant bibliography that covers food safety and security in humanitarian crises and disasters in the developing countries (Pingali et al., 2005; Rukundo et al., 2014; Tsuboyama-Kasaoka and Purba, 2014; Sonnino et al., 2016; Wrabel and Caiafa, 2019). This line of research attempts to understand the local conditions that led to the food emergency, in order to better define the short- and long-term strategies necessary to overcome the state of crisis (Marincioni, 2015). However, to the authors knowledge, little has been done for analyzing the food management in the aftermath of a disaster in the developed countries.

In Italy, food management following a disaster is mostly carried out by volunteer organizations, which has been previously identified and selected by the Civil Protection, as set in the Decree Law 1/2018 named “Civil Protection

Code". This study analyzed the management of the food services after the 24 August 2016 earthquakes, which involved several regions of central Italy (Lazio, Abruzzo, Marche and Umbria). Data collection was carried out through the administration of questionnaires, one month after the events, to two target groups: (i) the population hit by the earthquakes and the volunteer workers who used the services of the field kitchens, and (ii) the volunteers operating the field kitchen. Five campgrounds and related field kitchens located in the municipalities of Accumoli and Amatrice, in the Lazio Region, and in the municipality of Arquata del Tronto in the Marche Region, had been examined. The aim was to evaluate the food management in the aftermath of the earthquakes, by verifying if the conditions of food safety and security had been respected during the immediate and sustained phases of the emergency. Users' experience with the field kitchen services was investigated assessing, inter-alia, the quantity, the serving temperature and the waiting times for food distribution.

2. Case study: the earthquakes of 24 august 2016 in Central Italy

2.1. The seismic events

On 24 August 2016 two significant earthquakes hit Central Italy, a Mw = 6.0 event with an epicenter in the municipality of Accumoli, Lazio Region, recorded at 3.36 (UTC + 2), and a Mw = 5.4 event with an epicenter in the municipality of Norcia, Umbria Region, recorded at 4.33 (UTC + 2) (Pucci *et al.*, 2016). The ensuing infrastructural collapses killed 299 people and injured 365 others, while 4807 had been displaced requiring temporary assistance from the Civil Protection (Italian National Civil Protection Department, 2016a). The most affected municipalities were Arquata del Tronto (Marche Region), Accumoli and Amatrice (Lazio Region) (Pucci *et al.*, 2016). A total of 29 campgrounds were set up: 17 in Accumoli and Amatrice (Lazio Region) and 12 in Arquata del Tronto (Marche Region).

2.2. The response phase

The emergency response system was activated in the very early phases following the quakes. Reception camps and field kitchens were set up in the following days, and voluntary civil protection personnel on site was guaranteed. The Region with the highest number of displaced people was Marche, where within a week after the earthquake 2776 persons were assisted, either in the 12 reception camps or in the hotels along the Adriatic coast (not damaged). The municipalities most affected in the Marche Region were: Acquasanta Terme, Amandola, Arquata del Tronto, Castelsantangelo sul Nera, Montegallo, Montemonaco and Montefortino. Many governmental and volunteer organizations worked with the national and regional civil protection departments (e.g. the National Association of Public Assistance - ANPAS, the fire department, the Carabinieri corps, the Red Cross, etc.). The Marche Region civil protection department coordinated 50 full time workers and about 350 specialized volunteers operating across the affected areas; half of them were employed in Arquata del Tronto, dealing also with the distribution of meals to the displaced population and to the civil protection volunteer.

In the Lazio Region, 17 reception camps and 3 "micro-camps" were set up and managed by the Lazio Civil Protection, the Italian Red Cross, the Friuli Venezia Giulia, the Molise and the Tuscany Regions as well as various voluntary associations. The municipalities most affected in Lazio were Amatrice and Accumoli. As of 29 August 2016, in the municipality of Amatrice a total of 526 displaced persons and 210 volunteers and Civil Protection workers were hosted in four main reception camps and three "micro-camps" (hosting 20 people each). In Accumuli three reception camps hosted a total of 134 displaced persons and about 80 volunteers and civil protection workers.

3. Methodology

In order to verify if the conditions of food safety and security had been respected during the immediate and sustained phases of the emergency, questionnaires were administered to victims, emergency workers and volunteers of five field kitchens set up in the various reception camps (Table 1).

The studied field kitchens were selected among those active at the time of the surveys, carried out from 23 September to 1 October 2016. The reason of this specific timing for the survey is that after one month it was possible to evaluate both the immediate and the sustained phases of the emergency, because the former was over and the latter with its food supply chain was fully established.

For the sampling, an accidental non-probabilistic technique (Sarantakos, 2005) was used. Through this technique, each individual met during meal times at the field kitchens canteen was considered valid unit for the purposes of the investigation (Bird & Dominey-Howes, 2008).

3.1. The field kitchens

Two of the five studied field kitchens were located in the Marche Region, in the municipality of Arquata del Tronto (hereafter “Arquata 1” and “Arquata 2”), managed respectively by the Citizen’s Club Enrico Mattei, and by the Marche Region Committee of ANPAS. The other three studied field kitchens were located in the Lazio Region; one in the municipality of Accumoli, managed by the Tivoli Radio-Rescue Volunteers Association - AVRST (hereafter “Accumoli”), and two in the municipality of Amatrice (hereafter “Amatrice 1” and “Amatrice 2”) managed respectively by the Lazio Region Civil Protection and by the national coordination of ANPAS. Table 1 lists the field kitchens surveyed, Figure 1 shows their locations and Figure 2 shows a collage of some pictures taken during the surveys.

Field kitchen ID	*Place*	*Managing association*	*N° of Questionnaires*		
			Population	*Volunteers*	*Operatives*
Arquata 1	Arquata del Tronto (Marche Region)	CB Club Enrico Mattei	90	-	5
Arquata 2		ANPAS (Marche Region)	-	12	5
Accumoli	Accumoli (Lazio Region)	AVRST	-	-	5
Amatrice 1	Amatrice (Lazio Region)	Lazio Region Civil Protection	92	-	5
Amatrice 2		ANPAS	-	15	5

		182	27	25

Table 1 - *List of the five field kitchens selected for the study, their location, the managing volunteer associations and the number of collected questionnaires in each of these field kitchen's precincts.*

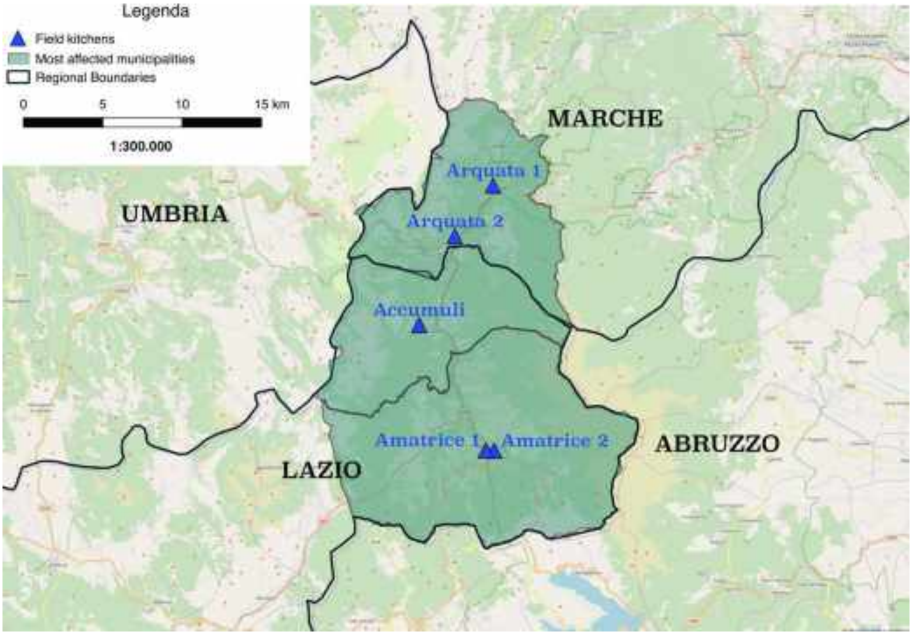

Figure 1 - *Map displaying the location of the five field kitchens selected for the study*

Figure 2 - *Pictures of the surveyed campgrounds and field kitchens: (a) the dining area in Amatrice 2, (b) the field kitchen in Amatrice 1, (c) campground in Arquata 1, and (d) example of menu in Amatrice 1 (copyrights of the Authors).*

3.2. Structure of the questionnaires and survey

Two questionnaires had been developed to collect data. Questionnaire 1 was calibrated and administered to the population and the civil protection volunteers who used the dining service, whereas Questionnaire 2 was designed for the field kitchen operatives.

Questionnaire 1 consisted of 19 questions, mostly multiple choice and open-ended types, divided into 4 sections: (i) availability of food resources after the earthquake (questions 1-5); (ii) quality and quantity of food provided by the field kitchen (questions 6-7); (iii) overall experience with the field kitchen services (questions 8-13); (iv) demographic data, such as age, sex, and family status (questions 14-19). Specifically, in the first section the focus was on the time elapsed from the earthquake event to the first access to drinking water and food (questions 1 and 2) before the field kitchen was set up (question 3), and before the dining services were activated (question 4). Furthermore, it was asked how long had passed before it was possible to independently gain access to food and drinks (e.g. shops, farms, relatives, etc.) (question 5). In the second section, the adequacy of the quantity (question 6) and the serving temperatures (questions 7a, 7b and 7c) of the food were evaluated. The third section investigated the waiting times for food distribution (question 8), the cleaning of the field kitchen areas and utensils (questions 9 and 10) and the possible onset of illnesses due to the food served (questions 11a and 11b). Then it was asked to evaluate the overall experience with field kitchen services (questions 12 and 13).

Questionnaire 2 consisted of 30 questions, mostly multiple choice and open-ended types, divided into 6 sections: (i) installation and operation of the field kitchen (questions 1-5); (ii) menus and users (questions 6-7 and questions 17-20); (iii) equipment (questions 8-11); (iv) type and availability of food (questions 12-16); (v) hygiene and controls (questions 21-22); (vi) demographic data, regarding the role of the interviewees and their organization (questions 24-30). Specifically, in the first section were investigated how much time has passed, after the earthquake, before the field kitchen started working (question 1), before drinking water (question 2), electricity, and gas (question 4) were available, and whether this availability was adequate to the situation (questions 3 and 5). In the second section, it was investigated how many meals were served on average for breakfast, lunch and dinner (question 6) and who were the main users (question 7). Responders were asked to provide examples of daily or weekly menus served (question 17), or requests of special diets (e.g.: low-calorie diets, diets for celiac) (question 18). In this section field kitchen volunteers were also asked to describe the relationship with the people they served / field kitchen's users (question 19). In the third section, it was asked whether the equipment for food preservation (question 8), cooking and processing (question 9), distribution (question 10) and for cleaning food and utensils (question 11) were suited for the emergency use. In the fourth section, it was asked if the type of ingredients (question 12) and quantity (question 13) were enough. The qualitative aspect of the food, namely if it was sufficiently fresh (question 14) and accessible (question 15), was also investigated. Furthermore, it was considered the quantity, type and utility of donated food (question 16). The fifth section of the questionnaires assessed the hygienic conditions of the field kitchens (question 21). Lastly, the interviewees could report their own considerations, experiences with the field kitchen and provide recommendations to enhance the services (question 23).

4. Results and discussions

A total of 234 individuals answered the questionnaires; 182 residents, 27 volunteers, and 25 field kitchens operatives (Table 1).

The demographic statistics of Questionnaire 1, administered to local population and volunteers, are summarized in Table 2. The various categories of respondents had been evenly distributed between women and men, except for the volunteers in Amatrice. Four age groups were also defined: <25-year-olds (youngsters), 25-year-olds to 45-year-olds (young adults); 46-year-olds to 60- year-olds (adults), and >60-year-olds (senior citizens). All the age groups were well represented, especially among the population, while most of the volunteers were young adults (58% in Arquata and 47% in Amatrice). The population interviewed were mostly employees (39% and 48%), freelancer (20% and 19%), students (10% and 15%), and retirees (22% and 11%). A similar distribution was obtained among the volunteers of Amatrice. Half of the interviewed were married, except for the volunteers in Amatrice the majority of which (87%) were not married. Finally, most of the respondents had neither underage (>58%) nor adult (>53%) children.

The analysis of the availability of food resources after the earthquake (Table 3), pertaining to the immediate phase of the emergency, shows that most of the population of Arquata (92%) and Amatrice (73%) had drinking water within 6 hours and food within 12 hours (94% and 74% respectively) after the earthquake. As for the setting up of the field kitchen, the population of Amatrice waited less than 12 hours (57%), while in Arquata had to wait more than 2 days (57%). An interesting finding was that 71% of the population of Arquata stated that they could access/obtain food/drink independently since the first week after the earthquake, while in Amatrice the percentage is 59%. In Amatrice, the social fabric of the city had been destroyed, thus inhibiting the population to get food from other sources. Over time, as the social interaction begun to function again, along with the opportunities to obtain food externally of the field kitchens. In the context of Arquata the surrounding countries have continued to function, making quite simple to obtain food, especially vegetables from the local farmers. Conversely, the volunteers working both in Arquata or Amatrice reported difficulties to access food outside of the field kitchen even a month after the earthquake (92% and 93% respectively), probably because they did not have a good knowledge of or ties with the local territory.

In terms of quality and quantity of food provided by the field kitchen (Table 3), pertaining to the sustained phase of the emergency, in Arquata 70% of the population stated that the quantity of the meals was proper and 58% of the volunteers consider it abundant. Food was abundant also in Amatrice (for 54% of the population and 53% of the volunteers). Almost all the interviewees declared that the serving temperature of food, both hot or cold types, was adequate for a correct conservation. This finding shows that the field kitchen had adequate facilities for food conservation.

In Arquata a small part of the population declared that they had waited for meals as long as 15-30 minutes (4%) or even higher than 30 minutes (4%), while the majority reported short waiting times: less than 5 minutes (49%) to a max of 15 minutes (43%). The experience accounted by the volunteers was slightly better, as their waiting time was shorter; 6-15 minutes (75%) or less (25%). In the case of Amatrice most of the population maintained that they usually waited between 6-15 minutes (73%), and never more than half an hour. Here the volunteers accounted for very brief waiting times; 5 minutes or less (60%). It is likely that the volunteers used the field kitchens service at different times compared to the population. Furthermore, all the interviewees agreed on the good or excellent cleanliness of the dining areas. When asked about the possibility of sickness related to food eaten in the field kitchen, only a few individuals of Arquata claimed that they had a stomachache due to custard pies (2%) or vegetables (1%). The rest of the population attributed stomachache problems to stress (6% Arquata and 2% Amatrice). None of the volunteers declared sickness related to food eaten in the field kitchen.

In general, the population rated the field kitchen experience as good (68% Arquata and 50% Amatrice) or excellent (20% Arquata and 46% Amatrice) (Table 3). The evaluation of the volunteers was excellent (50% Arquata and 67% Amatrice) or good (50% Arquata and 33% Amatrice). However, in spite of the fact that most of the respondents have been satisfied with the service (17% people Arquata and 13% people Amatrice), the kindness and availability of the operatives (7% Arquata), a certain dissatisfaction emerged about the variety of the proposed menus (10% Arquata and 5% Amatrice). The interviewees of Arquata (3%) proposed to replace the pasta with soup, minestrone or rice and to reduce the use of cream and butter. The interviewees of Amatrice (7%) requested more vegetables and the possibility to have more than one choice for the first and second courses. Some elderly, both in Arquata (2%) and Amatrice (3%) complained that the dining areas were too cold in the evening. Others lamented the impossibility to cook for themselves, missing a certain independence to choose what to eat (2% Arquata and 1% Amatrice). A common response across the various field kitchens (6% Arquata and 2% Amatrice) was the change of procedures and menus from one shift of volunteers to the next (a shift generally lasted one week).

	Population		*Volunteers*	
	Arquata 1	*Amatrice 1*	*Arquata 2*	*Amatrice 2*
	N (%)	*N (%)*	*N (%)*	*N (%)*
	90 (100%)	*92 (100%)*	*12 (100%)*	*15 (100%)*
Demographic data				
14) Gender:				
Male	46(51%)	43(47%)	5(42%)	11(73%)
Female	44(49%)	49(53%)	7(58%)	4(27%)
15) Age:				
< 25	16(17%)	18(20%)	2(17%)	5(33%)
26 – 45	23(26%)	32(35%)	7(58%)	7(47%)
46 – 60	28(31%)	30(32%)	2(17%)	1(7%)
> 60	23(26%)	12(13%)	1(8%)	2(13%)
16) Occupation:				
Employee	35(39%)	44(48%)	0(0%)	9(60%)
Freelance	18(20%)	17(19%)	0(0%)	2(13%)
Student	9(10%)	14(15%)	0(0%)	4(27%)
Retiree	20(22%)	10(11%)	0(0%)	0(0%)
Medical/nursing staff	0(0%)	2(2%)	0(0%)	0(0%)
Housewife	2(2%)	5(5%)	0(0%)	0(0%)
Unemployed	6(7%)	0(0%)	0(0%)	0(0%)
Volunteer	0(0%)	0(0%)	12(100%)	0(0%)
17) Married				

Yes	51(57%)	45(49%)	6(50%)	2(13%)
No	39(43%)	41(44%)	6(50%)	13(87%)
No answer	0(0%)	6(7%)	0(0%)	0(0%)
18) Number of underage children:				
0	66(73%)	57(62%)	7(58%)	13(87%)
1	15(17%)	17(19%)	2(17%)	0(0%)
2	9(10%)	14(15%)	3(25%)	0(0%)
3	0(0%)	4(4%)	0(0%)	2(13%)
19) Number of adult children:				
0	48(53%)	61(66%)	10(84%)	11(73%)
1	21(23%)	9(10%)	1(8%)	1(7%)
2	21(23%)	17(19%)	1(8%)	2(13%)
3	2(1%)	3(3%)	0(0%)	1(7%)
4	0(0%)	2(2%)	10(84%)	11(73%)

Table 2 - *Questionnaire 1: Demographic statistics of the interviewed population and volunteers who used the field kitchens of Arquata del Tronto and Amatrice.*

Population		Volunteers	
Arquata 1	Amatrice 1	Arquata 2	Amatrice 2
IMMEDIATE PHASE			
Availability of food resources after the earthquake			
Drinking water in less than 6h (92% and 73%)		-	-
Access to food in less than 12 hours (94% and 74%)		-	-
Field kitchen set up in more than 2 days (57%)	Field kitchen set up in less than 12 hours (57% and 100%)		Field kitchen set up in 1 day (93%)
Daily use of the kitchen services (87% and 80%)		Occasional or 1 week use of the kitchen services (84%)	1 week use of the kitchen services (93%)
Independent access to food/drinks from the first week (71% and 59%)		No independent access to food/drink (92% and 93%)	

SUSTAINED PHASE		
Quality and quantity of food provided by the field kitchen		
Enough food served (70%)	Plentiful food served (54%, 58%, and 53%)	
Adequate serving temperature for hot foods (82%, 100%, 100%, and 100%)		
Adequate serving temperature for cold foods (73%, 83%, 83%, and 100%)		
Overall experience with the field kitchen services		
Less than 5 minutes of waiting for food distribution (49%)	6-15 minutes of waiting for food distribution (73% and 75%)	Less than 5 minutes of waiting for food distribution (60%)
Clean or very clean field kitchen areas (100%, 98%, 100%, and 100%)		
Clean or very clean utensils used in the field kitchen (100%, 100%, 100%, and 100%)		
Suffering of stomachache after eating in the field kitchen (9%, 3%, 0%, and 7%)		
Stomachache attributable to food eaten in the field kitchen (3%, 0%, 0%, and 0%)		
Good or excellent experience with the field kitchen services (88%, 96%, 100%, and 100%)		

Table 3 - *Comparison of Questionnaire 1 answers across all the field kitchen surveyed. Response rates are given in brackets.*

The demographic statistics of Questionnaire 2, administered to the operatives of all studied field kitchens, are summarized in Table 4. Although not all figures composing the organizations structure were reached in all field kitchens, the deputy manager, the cook, the cook assistant, the manager and operatives of food distribution have been contacted. In Arquata 1 and 2, Accumoli and Amatrice 2, the cooks were professionals who did the same job in their regular life. Almost all the interviewees maintained that they had obtained certification for food safety, except for some of the managers and operatives of Arquata 2, Accumoli, and Amatrice 2. Moreover, most of the organizations had already deployed from 4 to 6 shifts in the studied campgrounds, and all the members of their organization had been employed in the field kitchen. Finally, all respondents had previous experience in operating a field kitchen during an emergency.

For what concern the immediate phase, the time required to set up the field kitchens (Table 5) varied a bit among the various campgrounds. Arquata 2 and Amatrice 1 had their field kitchen set up and ready in less than 12 hours. In Accumoli and Amatrice 2 the field kitchens were ready after 1 day, whereas in Arquata 1 it was necessary 2 days. All operatives declared that they had immediately access to adequate volume of drinking water, electricity and gas within the 12 hours succeeding the earthquake, except for the operatives of Arquata 1 who declared full availability within 2 days, in line with the kitchen installation times.

Regarding the management of the sustained phase, at the time of the surveys the number of meals served by the kitchens of Arquata 1 and Amatrice 1 and 2 was around 300-400, while that of Arquata 2 and Accumoli was around 100 (Table 5). All field kitchens recorded peaks of attendance at lunch. The meals were served to population, volunteers, and institutional emergency staff, except for Arquata 2 whose recipients were only voluntary rescue personnel. The daily menus for lunch and dinner offered: 1 first course (mainly pasta), 1 second course, 1 side dish, and fruit or dessert. These menus offered no alternatives to the proposed first, second or side dish. Only the kitchen of Accumoli offered, at times, a second choice for the first and second courses, but only for lunch. All field kitchens operatives claimed to have been prepared to respond to special dietary needs, such as low-calorie régimes, allergies (e.g. celiac disease), or food for infants. In regard to the use of leftovers, the interviewees of the kitchens of Arquata 1 and Amatrice 1 declared to re-propose them at the following meals, those of Arquata 2 and Amatrice 2 threw leftovers away (depending on the situation), while those of Accumoli transformed leftovers (e.g. meatloaf, omelet, sauces, etc) and offered them in the next meal.

In terms of kitchen equipment (Table 5), positive or very positive comments have been reported by the operatives on the available tools for cleaning and preparing ingredients, preserving, cooking, transforming and distributing food as well as for the washing and sanitizing utensils and tableware. Some negative comments were expressed by the operatives of the field kitchen of Arquata 1, which although designed to serve 100 people, did in fact prepare meals for more than 350 users since the beginning of the emergency. However, all field kitchens have been subjected to health checks by the authorities in charge of public health (Table 5).

The variety and quality of food were generally considered adequate or very adequate, except for a specific issue referring to the suitability of food for the field kitchen of Amatrice 2 (Table 5). Due to a bureaucratic hindrance, the ingredients arrived on site with a delay of 3-4 days from the time of order; eventually the regulatory process was bypassed in order to timely get what the needed ingredients. All respondents agreed on the quantity and freshness of food. A large amount of fresh and canned ingredients came from donations, both from individuals or corporations, e.g.: pasta, peeled tomatoes, biscuits and brioche, but also coffee, canned food, water and milk. In some cases, this over-abundance of donated food led to logistical problems. In the end, to avoid waste of perishable food, the donated fresh ingredients that were in surplus were re-routed to non-profit organizations that deal with assistance to people in need in Italy (National Department Civil Protection, 2016b).

	Arquata 1	*Arquata 2*	*Accumoli*	*Amatrice 1*	*Amatrice 2*
Demographic data					
How many people in your organization were employed in this emergency?					
People	23	12	12	10	65
How many people are needed for effectively managing this field kitchen?					
People	23	12	12	6	25
What is your role in the field kitchen?					
Cook	1	1	1	1	1
Cook assistant	1	1	1	1	0
Distributor and table manager	2	2	2	3	2
Other: Coordinator	1	1	0	0	0
Other: Deputy manager of the field kitchen	0	0	1	0	0
Other: Field kitchen manager	0	0	0	0	1
Other: Reception camp manager	0	0	0	0	1
How many shifts did your organization perform in this emergency?					
Shifts	4	4	6	4	6

Table 4 - *Questionnaire 2: Demographic information from the interviewed operatives who worked in the field kitchens of Arquata del Tronto, Accumoli, and Amatrice.*

Arquata 1	*Arquata 2*	*Accumoli*	*Amatrice 1*	*Amatrice 2*
IMMEDIATE PHASE				

Installation and operation of the field kitchen				
Set up in 2 days (100%)	Set up in less than 12 hours (100%)	Set up in 1 day (100%)	Set up in less than 12 hours (100%)	Set up in 1 day (100%)
Drinking water in 2 days (100%)	Drinking water in less than 12 hours (100%, 100%, 100%, and 100%)			
Adequate drinking water for the need of the kitchen (100%, 100%, 100%, 100%, and 100%)				
Electricity and gas in less than 12 hours (100%, 100%, 100%, 100%, and 100%)				
Adequate electricity and gas for the need of the kitchen (100%, 100%, 100%, 100%, and 100%)				
SUSTAINED PHASE				
Menus and recipients				
350-400 meals served	100-170 meals served	100-170 meals served	200-300 meals served	400-450 meals served
Population, Volunteers, Institutions	Volunteers	Population, Volunteers, Institutions	Population, Volunteers, Institutions	Populatio n, Institutions
Leftovers re-proposed (100%)	Leftovers thrown away (100%)	Leftovers transformed (100%)	Leftovers re-proposed (100%)	Leftovers thrown away (60%)
Equipment				
Adequate food storage facilities (80%)	Very adequate food storage facilities (60%, 80%, and 100%)			Adequate food storage facilities (100%)
Inadequate cooking and food processing facilities (20%)	Very adequate cooking and food processing facilities (100%, 100%, and 60%)			Adequate cooking and food processing facilities (100%)
Adequate food distribution facilities (80% and 100%)		Very adequate food distribution facilities (100%)	Adequate food distribution facilities (100% and 60%)	
Adequate cleaning facilities (60% and 60%)		Very adequate cleaning facilities (80%)	Adequate cleaning facilities (100% and 60%)	
Type and availability of food				

Adequate variety of ingredients (80%)	Very adequate variety of ingredients (60%, 60%, and 100%)	Inadequate variety of ingredients (20%)
Adequate quantity of ingredients (60%)	Very adequate quantity of ingredients (60%, 100%, and 100%)	Adequate quantity of ingredients (100%)
Fresh ingredients available (100%, 100%, 100%, 100%, and 100%)		
Satisfactory ingredients available (100%, 100%, 100%, 100%, and 80%)		
Food donation (100%, 100%, 100%, 100%, and 100%)		
Hygiene and controls		
Appropriate hygienic conditions (60%, 60%, and 80%)	Excellent hygienic conditions (100% and 80%)	
Hygienic checks by authorities in charge (100%, 100%, 100%, 100%, and 100%)		

Table 5 - *Comparison of Questionnaire 2 answers across all the field kitchen surveyed. Response rates are given in brackets*

5. Food management model

The above described findings in spite of portraying relatively functional food management services during the emergency, highlighted the need of standardized procedures to handle the various aspects of food in disasters. Figure 3 visualizes a proposed “Food management model in disasters” that we think adaptable to any type of emergency and rescue organization. Indeed, in the immediate aftermath of a disaster, the focus should be ensuring survival needs to the population (water and basic nourishment). Once an adequate assistance is provided in terms of basic nutrition needs, the model envisions a second phase in which the field kitchens has been set up. In this phase, called the sustained phase, the key elements to monitor are the food and the field kitchen operatives. Regarding the food, its security and safety must be continuously verified and monitored. If the food quantity is adequate, then "food security" is achieved. Conversely, if food quantity is inadequate, a request of help from the regional, national or international levels should be activated. The other aspect that must be verified is that the available food should not be contaminated microbiologically, chemically or physically to prevent food-borne illness. If this condition is true, then "food safety" is achieved. If not, the food cannot be served to avoid health issues in the campground, and menus, ingredients and food preparation procedures have to be reviewed. Attention should also be paid to issues related to food intolerances (e.g. celiac disease), as well as cultural and religious dietary precepts (e.g. vegetarians). The other key element to monitor in the sustained phase, are the field kitchen's operatives. They must be knowledgeable and respectful of the rules and procedures to avoid food contamination. Operatives of a field kitchen should have all the necessary training and certifications. Furthermore, to guarantee a smooth transition in terms of modus operandi and menus, from a shift of filed kitchen operatives to the next, it may be necessary to set some standards and foresee the presence of a transitional manager that guarantees continuity. The third and last phase of the proposed food management model, concerns the long-term phase in which the population should be helped to return to a normal condition of independent food preparation and consumption.

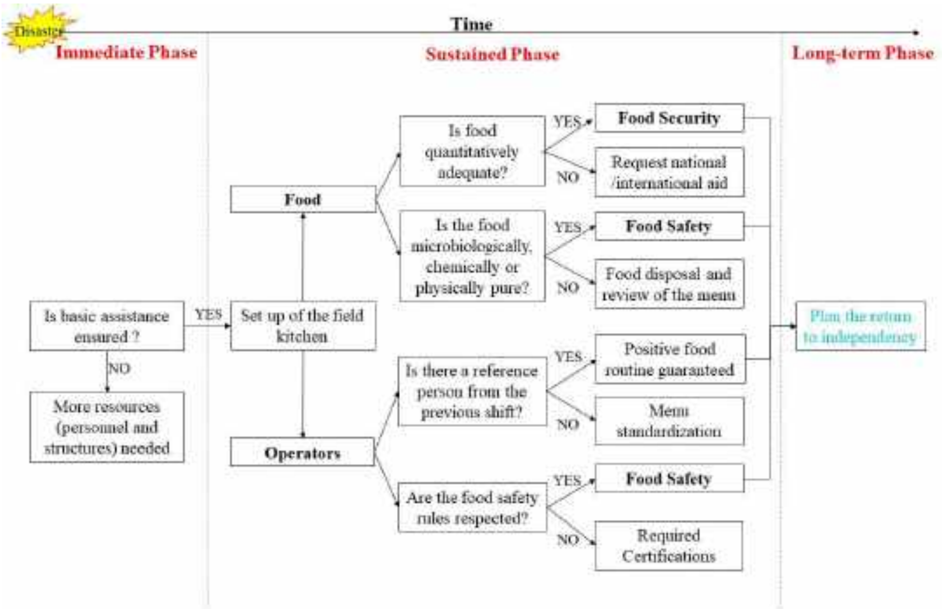

Figure 3 - *Food management model in disasters.*

6. Conclusions

This study investigated the management of food services for the population affected by the earthquake of 24 August 2016 in Central Italy. The analysis focused on the immediate phase, including the first 72-96 hours from the event, and the sustained phase, in which the main objective of the organizations is to prepare and distribute meals using field kitchens. Field surveys were carried out in five field kitchens located in the municipalities of Accumoli and Amatrice, in the Lazio Region, and in the municipality of Arquata del Tronto in the Marche Region. Data was collected by administering two questionnaires one month after the event. The first questionnaire focused on the users of the field kitchens (residents and the volunteer workers), while the second focused on the field kitchen operatives.

Results showed that the food services were provided without major problems in terms of hygienic-sanitary conditions or food shortage. “Food safety” was easily achieved because the Italian regulations requires that those who works in close contact with food, such as cooks and assistant cooks, must have previously obtained certification for food safety as well as undergone sanitary tests. Similarly, the studied field kitchen had to be equipped with adequate tools and facilities dedicated to properly clean and process food. Also important were the repeated controls of the field kitchens by the authorities in charge of the hygienic-sanitary conditions. “Food security” was also easily achieved because, in spite of the large extension of the damage area, the surrounding territories (including the national scale) kept functioning and were able to provide support to the less fortunate areas. Food shortage during this emergency was never a problem.

Overall, interviewed residents and volunteers that used the field kitchen services were generally satisfied. The quantity, the service temperature of the food and the waiting time in food distribution was deemed good. Similarly, all the studied kitchens were prepared to deal with particular dietary requests (e.g. celiac) or food practices (e.g. vegetarians). Also, the field kitchens operatives were satisfied with the resources (structures and personnel) available, which eased the management of the food emergency created by the earthquake. Kitchen modules were promptly equipped with basic services such as water, electricity and gas, and with adequate structures suitable for storage, cooking / processing and food distribution.

It is worth mentioning here the suggestions that emerged from the population, namely the request for greater variety of the proposed menus. Among the possible ways to ease this problem could be working with the untouched leftovers; rather than re-proposing them as they are or throwing them away, cooks could imagine creative ways to transform leftovers into new tasty dishes. Possibly a menu for leftovers transformation should be assembled and distributed to the field kitchens.

In conclusion, the proposed food management model in disaster, distilling the lesson learned during the 2016 seismic emergency in Central Italy, provides a rational approach to manage effectively food services in the aftermath of a disaster.

Acknowledgements: Authors are grateful to the anonymous reviewers for their valuable and constructive comments on an earlier version of the manuscript. This research is part of a master's degree thesis in "Environmental Sustainability and Civil Protection" at the Università Politecnica delle Marche and did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

Bird, D., Dominey-Howes, D., 2008, "Testing the use of a 'questionnaire survey instrument' to investigate public perceptions of tsunami hazard and risk in Sydney, Australia", *Natural Hazards*, 45, 1, 99-122.

FAO - Agricultural and Development Economics Division, 2006, "Food security", link: http://www.fao.org/forestry/13128-0e6f36f27e0091055bec28ebe830f46b3.pdf (last access 30/05/2019).

Italian Decree Law 2 January 2018, n. 1, "Civil Protection Code", published in the Gazzetta Ufficiale n. 17 of 22 January 2018.

Italian National Civil Protection Department, 2016a, "Terremoto Centro Italia", link: http://www.protezionecivile.gov.it/attivita-rischi/rischio-sismico/emergenze/centro-italia-2016 (last access 30/05/2019).

Italian National Civil Protection Department, 2016b, "Terremoto Centro Italia: firmata la convenzione tra Dipartimento, Regioni, Croce Rossa e Banco Alimentare Onlus", link: http://www.protezionecivile.gov.it/media-comunicazione/news/dettaglio/-/asset_publisher/default/content/terremoto-centro-italia-firmata-la-convenzione-tra-dipartimento-regioni-croce-rossa-e-banco-alimentare-onlus (last access 30/05/2019).

Marincioni, F., 2015, Cibo in emergenza; facilitare il ritorno alla normalità con i sapori della cucina locale. In: Leto, A. (Ed.), *Alimentazione, Ambiente, Società e Territorio per uno sviluppo sostenibile e responsabile. Contributi e riflessioni geografiche a partire dai temi di EXPO 2015*. Ambiente Società Territorio Geografia nelle Scuole, 60, 55-58.

Pingali, P., Alinovi, L., Sutton, J., 2015, "Food Security in Complex Emergencies: Enhancing Food System Resilience", *Disasters*, 29, S1, S5–S24.

Pucci, S., De Martini, P.M., Nappi, R., Pantosti, D., Civico, R., Ricci, T., Moro, M., Cinti, F., Brunori, C.A., Di Naccio, D., Sapia, V., De Ritis, R., Gori, S., Falcucci, E., Caciagli, M., Pinzi, S., Villani, F., Gaudiosi, G., Burrato, P., Vannoli, P., Kastelic, V., Montone, P., Carafa, M., Patera, A., Vallone, R., Saroli, M., Lo Sardo, L., Lancia, M. (EMERGEO Working Group), 2016, "Terremoto di Amatrice del 24 agosto 2016: Effetti Cosismici", https://zenodo.org/record/61566#.XPBAOogzbIV (last access 30/05/2019).

Rukundo, P. M., Iversen, P. O., Oshaug, A., Omuajuanfo, L. R., Rukooko, B., Kikafunda, J., Andreassen, B. A., 2014, "Food as a human right during disasters in Uganda", *Food Policy*, 49, 1, 312-322.

Sarantakos, S., 2005, *Social Research,* 3rd edition, Palgrave Macmillan Hampshire, London.

Sonnino, A., Chuluunbaatar, D., Ruane, J., 2016, "Food security, sustainability and agricultural innovation", *Geotema*, 52, 27-30.

Sphere Association, 2018, *The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response*, 4th edition, Geneva, Switzerland.

Tsuboyama-Kasaoka, N., Purba, M.B., 2014, "Nutrition and earthquakes: experience and recommendations", *Asia Pac J Clin Nutr.*;23, 4, 505-13.

U.S. National Mass Care Strategy, 2015, "Multi-agency feeding support plan template", link: http://www.nationalmasscarestrategy.org/wp-content/uploads/2015/09/MAFSPT_v2_June_2015.pdf (last access 30/05/2019).

Wrabel, M., Caiafa, K., 2019, Food Emergency Operations After Natural Disasters, *Encyclopedia of Food Security and Sustainability*, 1, 135-141.

Section II

Resilience and Post-Disaster Recovery

9. An historical flight and some open questions towards a pluralistic but holistic view of resilience

Maurizio Indirli[*]

Abstract

The term "resilience", found for the first time in several Latin authors, then passed through medieval culture until intellectuals who strongly contributed to the birth of the modern scientific method (as Francis Bacon), 19th century encyclopedists, the Rankine's quantitative definition in engineering, and finally to psychology, anthropology, and ecology, with the fundamental Holling's contribution in 1973. In the last decades, the concept expanded quickly into social-ecological systems, disaster/risk assessment, sustainability, and adaptive capacity to cope catastrophic scenarios. Nowadays, multi-disciplinary scientists and representatives of public/private organizations largely use the term "resilience", but with increasing ambiguity about its properties and attributes. This work presents an *excursus* through the ages and a brief (not exhaustive, of course) *state-of-the-art* regarding "resilience", pointing out some open questions of the current debate among researchers of different disciplines, working in the fields of hazard mitigation, sustainability, risk assessment, heritage preservation, and so on.Increasing popularity but still scarce unification depict the situation; resilience still necessitates a robust effort of further multi-, inter-, trans-disciplinary research, going beyond the current fragmentation. Impressive tools supplied by Geomatics/Big Data management and extraordinary potentialities available from complex mathematical models give us now the opportunity to create 'a network of networks'; but the fast run of technology cannot be separated by a slower and shared *Peripatetiké Scholé*, exploring philosophical and scientific theories with a pluralistic but holistic view.

Finally, this work presents open questions and suggestions of some nuclei of future research regarding "resilience" (*safety*, *robustness*, *adaptive capacity*, *sustainability*, *governance*, *anamnesis*) that might be exploited in future studies.

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Keywords: Resilience, Multi-hazard scenarios, Risk management

1. History

1.1 Resilience, origin and evolution of the concept: from the classic age to the end of 19th century

My curiosity about the concept of “resilience” has been stimulated after reading the “*etymological journey*” of Alexander (2013); then, I felt the need of a personal investigation, in order to bring a sharper focus on some crucial historical passages and connections.

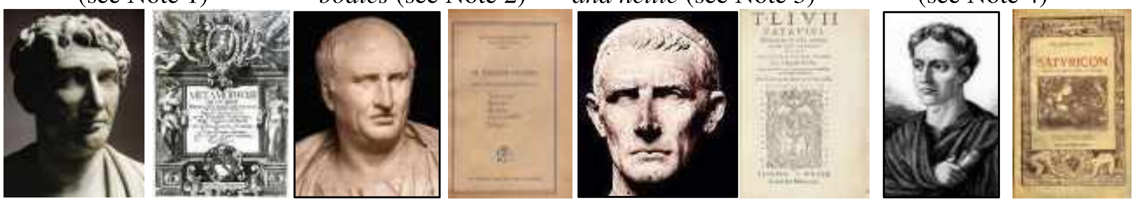
Some authors find captivating links with Ancient Greek Stoicism, Daoism, and Taoism (resilience as interpretation of detachment: Atkinson et al., 2009; Robertson, 2012; Morris, 2004; Wong, 2006; resilience as warrior self-governance, Sherman, 2005). Anyway, I believe that the current term indisputably appears in the Latin writings of Marcus Vitruvius Pollio[1], Titus Lucretius Carus[2], Gaius Plinius Secundus Maior[3], Lucius Annaeus Seneca Maior[4], Lucius Annaeus Seneca Minor[5], Publius Ovidius Naso[6], Marcus Tullius Cicero[7], Titus Livius[8], Marcus Fabius Quintilianus[9], Lucius Enneus Florus[10], Gaius Petronius Arbiter[11], and later Ammianus Marcellinus[12], Flavius Vegetius Renatus[13], among others (Figure 1).

Marcus Vitruvius Pollio, De Architectura: acoustics in theaters (see Note 1)

Titus Lucretius Carus, De Rerum Natura: void and resistance of bodies (see Note 2)

G. Plinius Secundus Maior, Naturalis Historia:fishes, honey and nettle (see Note 3)

Lucius Annaeus Seneca Maior, Controversiae: sentence of the priestess (see Note 4)



Publius Ovidius Naso, Metamorphoses: sailing, swimming, fighting

Marcus Tullius Cicero, Pro Roscio Armerino:

Titus Livius, Ab Urbe Condita:

Gaius Petronius Arbiter,Satiricon: the young slave

(see Note 6)	*accuse rebounds from own client* (see Note 7)	*skittish elephants in Zama battle* (see Note 8)	(see Note 11)

Figure 1 - *Appearance of the term resilience in Latin authors.*

In Latin (Liotta et al., 2010), *resilire* (rĕsĭlĭo, rĕsĭlis, resilui, rĕsĭlīre; resilĭens -ĕntis) means the act of rebounding, i.e. to rebound/recoil, from "re-" back + "salire" to jump, leap. It is used in architecture (Vitruvius), natural sciences (Lucretius, Plinius Maior), law and religion (Seneca Maior, Seneca Minor, Cicero, Quintilianus), literature (Ovidius, Petronius), history (Livius, Florus, Marcellinus, Renatus), giving the description of daily experiences in tangible or metaphorical sense (rebounding, leaping, shrinking, drawing back, retreating).

Plutarch (50; after 120 AD; Romanized Greek born at Chaeronea) analyzed the personalities of Lycurgus and Numa Pompilius in his *Parallel Lives* (Plutarch, 2001). He locates the cause for resilience somehow in the traits of the leaders, including virtues both moral and intellectual, and in the specific plans deemed necessary to bring about change to the societies of Sparta and Rome (Cusher, 2015).

Sofronius Eusebius Hieronymus[14] (St. Jerome), Ambrosius Mediolanensis[15] (St. Ambrose), and Aurelius Augustinus Hipponensis[16] (St. Augustine) use the word respectively in their *Epistolae*, *Hexameron*, and *Breviculus collationis cum Donatistis*. Resilire turns out again in *Historia Langobardorum* of Paulus Diaconus Warnefred Barnefridus Cassinensis[17] (Paul the Deacon) and *Legenda Major Sancti Francisci* of Bonaventura Bagnoregis[18] (Bonaventure). The term appears in other medieval authors as Isidorus Hispaliensis[19], Beda Venerabilis[20], Theodulfus Aurelianensis[21], Aelredus Rievallensis[22], Hugo Falcandus[23], and Boncompagnus de Signa[24].

The verb resilire is cited again by Gaufridus Monemutensis[25] (Galfridus Monumotensis, Geoffrey of Monmouth; Hammer, 1951) in his *Historia Regum Britanniae*, it is a popular chronicle originally in Latin, a valuable piece of medieval literature translated into several languages, although historically unreliable. Pietro Alighieri[26] and Guido da Pisa[27] use the word in their commentaries of *Divina Commedia* (by Dante Alighieri, 1265-1321; Alighieri, 1957). By the way, the impressive motto "*PERCUSSA RESILIUNT*" ("*struck they rebound*"; ascribed to Leone X, the Renaissance Medici Pope, as an ingenious allusion to the unstable fortune of his family; Valery, 1839) leaps out in the Hall of Elements, Pitti Palace, Florence, Italy.

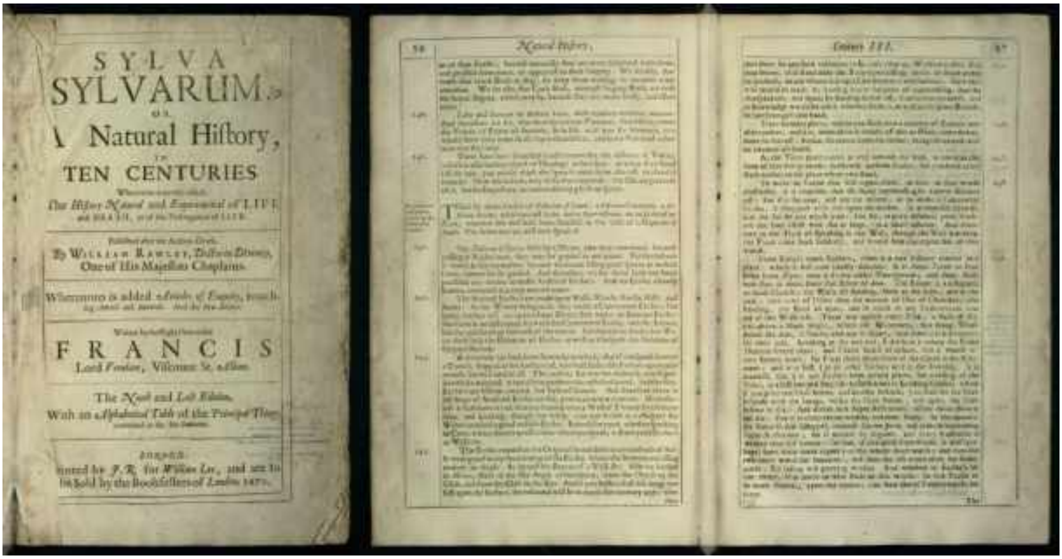
Coming from the sharp philological (pre-scientific) nucleus of the Classic Roman culture (therefore employed infrequently but properly), it seems that resilire, with its derivatives, rebounds from a thinker to another, through subsequent ages: sometimes keeping the original sense until to Giacomo Leopardi (1798-1837; Italian poet, philosopher, essayist, philologist; *Zibaldone di pensieri*, Leopardi, 1832); otherwise becoming ambiguous or capsized.

I neglect here the almost hidden passages (rather difficult to identify) into Romance languages (mention in Alexander, 2013: Middle French: “résiler”; English: “resile”), and remember *en passant* some historicists of the same period (example: Johannes Cluverus[28] or Iohannis Clüver, *Historiarum Totius Mundi Epitome*). In fact, it could be more productive to investigate the work of eminent bilingual (Latin/English; Latin/Romance) intellectuals who strongly contributed to the birth of the modern scientific method. They are Franciscus Baconus de Verulamio[29] (Francis Bacon), Renatus Cartesius[30] (René Descartes), and Galileo Galilei[31].

Bacon uses resilience (and derivatives) both in Latin and English (*Novum Organum*, *Sylva Sylvarum*, Figure 2) to describe physical properties and natural phenomena; the same for Descartes (*Letter 110 to Mersenne* in French, translated into *Epistola CX Ad R.P. Mersennum*). Although Galilei seems to ignore the word, it appears in Latin writings of colleagues involved in epistolary exchanges or debates with him about astronomy and motion of bodies (examples: Honoratus Fabrius or Honoré Fabri, *Tractatus Physicus De Motu Locali*; Fortunio Liceti, 1577-1657, Italian physician, philosopher, scientist, *Liteosphoros, seu de Lapide Bononiensi*).

Thanks to the robust basis created by the above said scientists, Ralph Bohun[32] speaks of “resilition” in an important early systematic study of winds (*A Discourse concerning the origine and properties of wind*; Bohun, 1671), after collecting worldwide wind and storm data, including on the land/sea breeze regime, the seasonal Asian monsoonal flow, hurricanes, waterspouts, and tornadoes. The same does James Keill[33] (*An Account of Animal Secretion*; Keill, 1708), and later Thomas Campbell[34] (*A Philosophical Survey of the South of Ireland, in a series of letters to John Watkinson*; Campbell, 1778).

Thomas Blount[35] (Blount, 1656), Edward Phillips[36] (Phillips, 1658), and Ephraim Chambers[37] (Chambers, 1728) employ “resilience/resiliency/resilition/resilient” in their books (respectively: *Glossographia*: RE, Resiliency/Resilition, a leaping back, recoiling, or rebounding; see also Alexander, 2013; *The New World of English Words, or, a General Dictionary*: RE, Resiliency/Resilition, the State or Quality of that which is resilient, Resilient, leaping back, rebounding, or recoiling; *Cyclopaedia, or, an Universal Dictionary of Arts and Sciences*: REC, Recoil/Rebound, the resilition of a body, chiefly a fire-arm; or the motion whereby, upon explosion, it starts or flies backwards; Figure 3).


SYLVA SYLVARUM

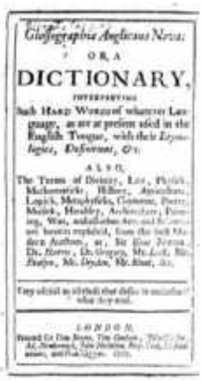
A Natural History,

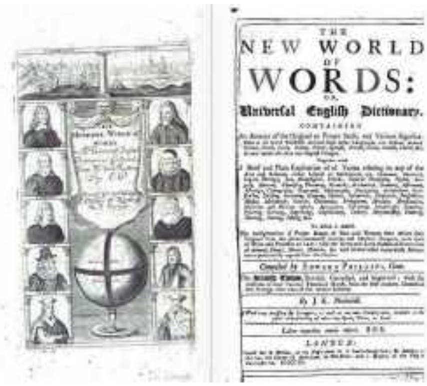
TEN CENTURIES

FRANCIS

Francis Bacon, Sylva Sylvarum, (see Note 29).

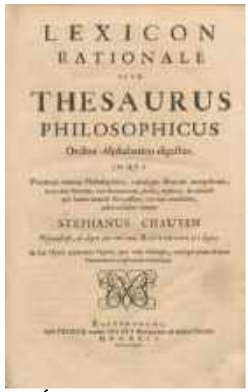
Figure 2 - *The concept of resilience in Francis Bacon.*


DICTIONARY,


THE NEW WORLD OF WORDS:


CYCLOPÆDIA:

ARTS and SCIENCES:


LEXICON RATIONALE

THESAURUS PHILOSOPHICUS

STEPHANUS CHAUVIN

Thomas Blount, Glossographia (see Note 35)

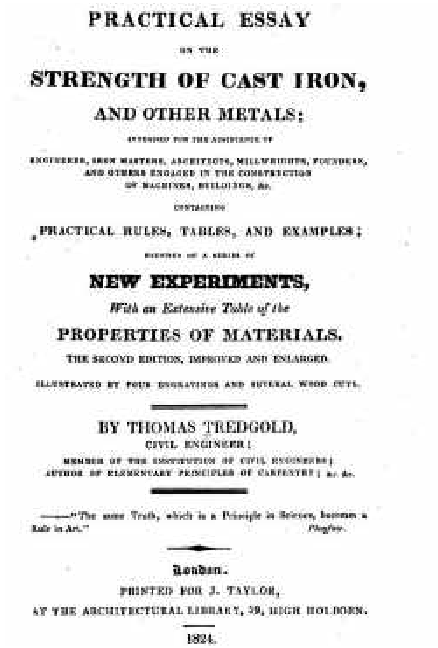
Edward Phillips, The New World of English Words or a General Dictionary (see Note 36)

Ephraim Chambers, Cyclopaedia (see Note 37)

Étienne Chauvin, Lexicon Philosophicum (see Note 38)

Figure 3 - *Appearance of the term resilience in English encyclopedists and in Chauvin (Latin).*

Stephanus Chauvin[38] (Étienne Chauvin; Chauvin, 1692) registered the definition of “resilientia” in his *Lexicon Philosophicum*. Denis Diderot[39] and Jean Baptiste Le Rond d’Alambert[39] are co-editors of the *Encyclopédie* (Diderot & Le Rond d’Alambert, 1751-65), inspired by the success of the above mentioned Chambers' volume, but the words "résiliation/résilier" are confined in the field of jurisprudence.



PRACTICAL ESSAY

ON THE

STRENGTH OF CAST IRON,

AND OTHER METALS;

CONTAINING

PRACTICAL RULES, TABLES, AND EXAMPLES;

NEW EXPERIMENTS,

With an Extensive Table of the

PROPERTIES OF MATERIALS.

THE SECOND EDITION, IMPROVED AND ENLARGED.

BY THOMAS TREDGOLD,

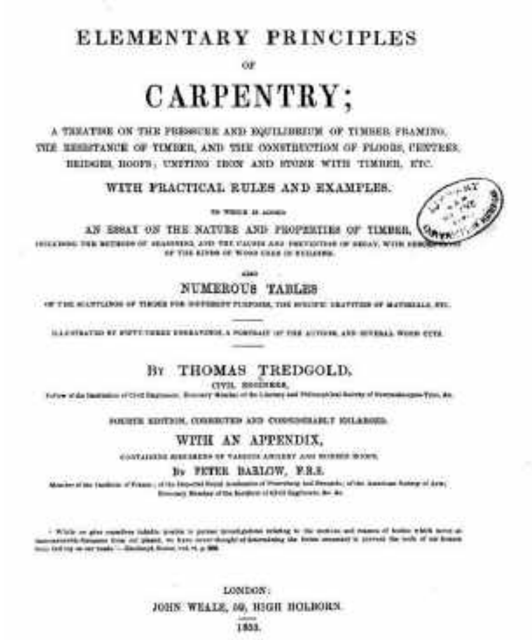
CIVIL ENGINEER;

London.

PRINTED FOR J. TAYLOR,

AT THE ARCHITECTURAL LIBRARY, 59, HIGH HOLBORN.

1824.



ELEMENTARY PRINCIPLES

OF

CARPENTRY;

WITH PRACTICAL RULES AND EXAMPLES.

AN ESSAY ON THE NATURE AND PROPERTIES OF TIMBER,

NUMEROUS TABLES

BY THOMAS TREDGOLD,

CIVIL ENGINEER,

WITH AN APPENDIX,

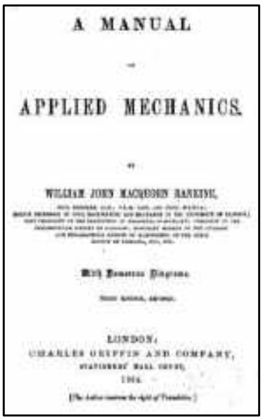
BY PETER BARLOW, F.R.S.

LONDON:

JOHN WEALE, 59, HIGH HOLBORN.

Thomas Tredgold (see Note 40)
Practical essay on the strength of cast iron, and other metals
Elementary Principles of Carpentry

Figure 4 - *Thomas Tredgold's important books.*

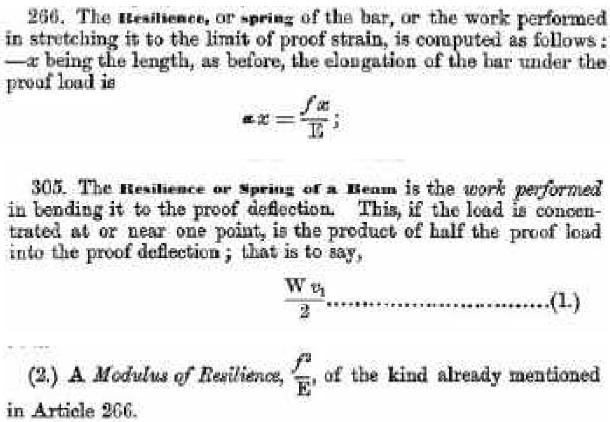


A MANUAL

APPLIED MECHANICS.

LONDON:

CHARLES GRIFFIN AND COMPANY,



266. The **Resilience,** or **spring** of the bar, or the work performed in stretching it to the limit of proof strain, is computed as follows: —x being the length, as before, the elongation of the bar under the proof load is

$$\alpha x = \frac{f x}{E};$$

305. The **Resilience or Spring of a Beam** is the *work performed* in bending it to the proof deflection. This, if the load is concentrated at or near one point, is the product of half the proof load into the proof deflection; that is to say,

$$\frac{W v_1}{2} \dots\dots\dots\dots\dots\dots\dots\dots (1.)$$

(2.) A *Modulus of Resilience*, $\frac{f^2}{E}$, of the kind already mentioned in Article 266.

William John Macquorn Rankine (see Note 41)

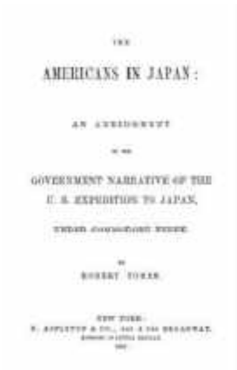
Figure 5 - *First quantitative definition of resilience: relation between force, ductility and resistance of beams.*

In general, advancing the Western scientific culture, resilience - and attributes - focuses on physical properties (rebounding of objects; elasticity of bodies; absorption of energy after impacts; reclaiming the original shape after deformation; sound reflecting; etc.).

The first definitions of resilience in engineering (timber and iron properties) can be found in Thomas Tredgold[40] (*Practical essay on the strength of cast iron, and other metals*; Tredgold, 1824; *Elementary Principles of Carpentry*; Tredgold, 1853; see also references in Haigh, 2015; Figure 4). Later, William John Macquorn Rankine[41] (*A Manual of Applied Mechanics*; Rankine, 1858-64; also reference in Alexander, 2013) provided quantitative formulae linking strength, ductility, and resilience of beams (Figure 5).

The same concepts, recalled in following technical-scientific books (Ewart Sigmund Andrews[42]; Andrews, 1908; 1913), spread immediately to the construction practice and industrial processes (Charles Frederick T. Young[43], *The fouling and corrosion of iron ships*, Young, 1867; William John Gordon[44], *Foundry, Forge and Factory*, Gordon, 1890; Andrew Wynter[45], *Subtle Brains and Lissom Fingers*; Wynter, 1869).

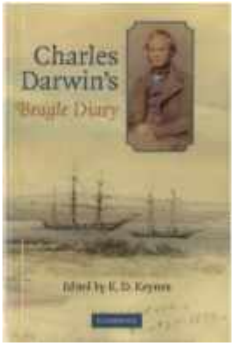
Furthermore, resiliency is found in Medicine (Robert Bentley Todd[46], *The Cyclopaedia of Anatomy and Physiology*; Todd, 1836-59; David James Hamilton[47], *A text-book of pathology systematic & practical*; Hamilton, 1889-94; Thomas Clifford Allbutt[48], *A System of Medicine by Many Writers*; Allbutt, 1901). The word also describes the ability to recover from adversity (Robert Bell[49], *Eminent literary and scientific men, English poets*; Bell, 1839; also reference in Alexander, 2013).


AMERICANS IN JAPAN:

GOVERNMENT NARRATIVE OF THE
U. S. EXPEDITION TO JAPAN,

Robert Tomes, The Americans in Japan (see Note 50)

Figure 6 - *Tomes's description of the earthquake/tsunami occurred in Shimoda, December 23rd, 1854.*




Book cover *Principal expeditions* *Remains of the cathedral of Concepcion, Chile*
Charles Darwin (see Note 51)

Figure 7 - *The Charles Darwin's Journey reported by his Beagle Diary.*

Robert Tomes[50] (*The Americans in Japan*, Tomes, 1857; also reference in Alexander, 2013; Figure 6) gives a sharp and astonishing description of the earthquake/tsunami sequence occurred in Shimoda, near Tokyo, on December 23rd, 1854, highlighting the adaptive capacity of Japanese people as resiliency and energy in their character.

Although Charles Darwin[51] does not mention explicitly the term resilience, he was quite shocked (Darwin, 1988, Figure 7) when he experienced a seismic event (earthquake and tsunami of Concepción/Talcahuano, Chile; February 20th, 1835, 11:30 local time, 15:30 UTC; estimated magnitude M_s=8.2, M_L=8.1). Furthermore, Charles Darwin and Robert Fitzroy witnessed the volcanic phenomena of Mount Osorno in Chiloe (November 26th, 1934). Darwin's observations about volcanos, earthquakes, and fossils contribute greatly to develop his thinking about the long-lasting age and transformation of the earth (but approximately only 6,000 year old for the Bible dogma in the dominant creationism of that period!). Consequently, also thanks to the study of the coral reefs growth, Darwin moved to the concept of 'coral of life' instead of 'tree of life', more appropriate for him to formulate the theory of the origin of species by natural selection (Darwin, 1859). *"Changes in the land created new environments and fostered adaptations in life forms that could lead to the formation of new species. Without the demonstration of the accumulation of multiple crustal events over time in Chile, the biologic implications of the specific species of birds and tortoises found in the Galapagos Islands and the formulation of the concept of natural selection might have remained dormant*" (Lee, 2010). Finally, the exceptional discontinuity marked by Darwin has been fundamental, more than one century later, for Crawford Stanley Holling, studying invading species and species in danger of extinction, to stress the separation of ecological resilience from stability, as different concepts and processes.

At this stage of our historic *excursus*, it is quite evident that the resilience flow, at the end of the 19th century, already presents, although in an embryonic state, the terms of future problematic conflicts, which will be emphasized by the growing up of multi-, inter-, trans-disciplinary approaches. A delimited and quantitative definition, born in applied contests of hard sciences, is going to be transferred to themes involving significantly social disciplines, until disaster assessment and civil protection, due to its undeniable metaphoric strength. The following direct quotation (Alexander, 2012; and 2013) summarizes perfectly the question: "*A resilient steel beam survives the application of a force by resisting it with strength (rigidity) and absorbing it with deformation (ductility). By analogy, the strength of a human society under stress is its ability to devise means of resisting disasters and maintaining its integrity (coherence), while the ductility lies in its ability to adapt to circumstances produced by the calamity in order to lessen their impact.*" Powerful and charming, the word resilience, acting as a prism scattering rapidly its original background into different directions, will catch the forthcoming and transversal attention of scientists, institutions, and citizens.

1.2. Resilience, origin and evolution of the concept: from the 20th century until today

The concept of resilience, built around the original nucleus belonging to the Latin culture, then renovated by the birth of the modern scientific method, offered broad description of phenomena in medicine, while engineering provided first quantitative formulae. In the second half of the 20th century, it spreads its complex potential towards different directions: again manufacturing (studies related to properties of yarn and woven fabrics: Hoffman, 1948; Beste & Hoffman, 1950), but especially psychology/anthropology (first), and ecology (later).

Donald A. Bloch (and colleagues) starts to analyze the effects of a disaster experience (December 5th, 1953 tornado of Vicksburg, Mississippi) on children in the community: "*A motion picture theatre, filled with children attending a Saturday afternoon movie, was particularly affected. For this reason, the Committee on Disaster Studies of the National Research Council felt that an unusual opportunity existed to study selectively the effects of the* *disaster experience on children in the community*" (Bloch et al., 1956). Then, the research develops towards competence/resilience in psychopathology (Garmezy, 1971 and 1973; Garmezy et al., 1984) and life experiences affecting resistance to psychiatric disorder (Rutter, 1985). Finally, continuity/change in competence/resilience over the transition to adulthood is interested, where: "*[...] resilience refers to the process of, capacity for, or outcome of successful adaptation despite challenging or threatening circumstances*" (Masten et al., 1990 and 2004; also: Alexander, 2013; Olsson et al., 2015; and references therein).

To summarize, resilience in psychology is "*a dynamic process of positive adaptation within the context of significant adversity, trauma, tragedy, threats, or significant sources of stress. [...] More recently, resilience [...] shifted the focus from individual resilience to include the role of social capital in communities in which individuals are embedded. Research on community resilience includes insights on health and human development, and can potentially be seen as an example of co-development with resilience theory in the context of socio-ecological systems (SESs)*" (Olsson et al., 2015; references therein).

In fact, the concept will expand in the following years until the definition of social resilience as the ability of: "*communities to withstand external shocks to their social infrastructure*"; "*a system to absorb perturbations*"; "*groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change*" (Adger, 2000).

The term resilience appears in an anthropology work regarding West African cultures, speaking about their greater mental resilience to shocks through conservation and adaptation (Herskovits, 1952). Other studies are between anthropology/psychology (Kagan, 1975) and anthropology/ecology (Lasker, 1969).

A couple of decades after the publication of *Outline of General System Theory* (von Bertalanffy, 1950), Crawford Stanley "Buzz" Holling[52] (Figure 8) worked on ideas originally proposed by Darwin[51] (1988 & 1859), reiterated by MacArthur (1955), modeled by May (1973) that species richness produces ecological stability (Peterson et al., 1998, and references therein). Holling, analyzing forest budworms, is the first scientist who adopts and defines precisely resilience in the field of ecology, making a clear distinction from the concept of stability (Holling, 1973; also Pimm, 1984; Gunderson et al., 1997 and 2009; Alexander, 2013; and references therein).

"*It is useful to distinguish two kinds of behaviour. One can be termed stability, which represents the ability of a system to return to an equilibrium state after a temporary disturbance; the more rapidly it returns and the less* *it fluctuates, the more stable it would be. But there is another property, termed resilience, that is a measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables*". Further, speaking about random events (affecting ecological systems considered non-deterministic), Holling says: "*they suggest that instability, in the sense of large fluctuations, may introduce a resilience and a capacity of resist*"; and finally in the synthesis, with definitions: "*I propose that the behaviour of ecological systems could well be defined by two distinct properties: resilience and stability. Resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and persist. In this definition, resilience is the property of the system and persistence or probability of extinction is the result. Stability, on the other hand, is the ability of a system to return to an equilibrium state after a temporary disturbance*" (quotations: Holling, 1973).

These definitions are certainly robust landmarks summarizing the research in rising ecology that followed the activity of Odum[53], 1971 (see also Thorén, 2014; and references therein).

Dynamic equilibrium and homeostatic reaction proper of ecosystems, captured by Holling's resilience, migrate quickly into other disciplines and attract researchers interested in sustainability/sustainable development and socioeconomic systems (Perrings, 1998; Levin et al., 1998; Batabyal, 1998).

The concept is used as a diagnostic indicator (Thorén, 2014; and references therein), informing analysis of change in economy-environment systems. In fact, some years later, "*the key point is that resilience is a measure of stability in the face of shocks […] in joint economy-environment systems*" and "*offers a helpful way of thinking about the evolution of social systems partly because it provides a means of analyzing, measuring and implementing the sustainability of such systems*" (quotation: Perrings, 1998).

Starting from a sentence contained in a declaration of the World Climate Conference ("*natural environments […] especially vulnerable or especially resilient to climatic variability and change*", WMO, 1980), Timmermann (1981; and references therein) speaks about resilience, analyzing the vulnerable society and reviewing some basic models/paradigms of social systems under stress. Same approaches are already used after Holling (1973) by other authors (Burton et al., 1978) and agencies (CSRG, 1979). Resilience is conceived "*as a concept describing the ability of a society to bounce back from severe stress*" and as "*the measure of a system's, or part of a system's capacity to absorb and recover from the occurrence of a hazardous event*" (quotation: Timmermann, 1981).

Crawford Stanley 'Buzz' Holling (see Note 52)

Figure 8 - *Adoption and definition of resilience in the field of ecology.*

The widespread impact of the Holling's work is quite impressive; anyway, in ecology and social sciences,"*although there is always a strong link to Holling's resilience, variation in the way different authors use the concept is considerable*" (Thorén, 2014), as shown by Table 1 (adapted from Brand & Jax, 2007).

In fact, some years later, Holling feels the need to clarify (Holling, 1996; and references therein). He distinguishes (quotations from Holling, 1996):

(i) *engineering resilience*, focusing on "*maintaining efficiency of function*", concentrating on "*stability near an equilibrium steady state, where resistance to disturbance and speed of return to the equilibrium are used to measure the property*";

(ii) *ecological resilience*, focusing on "*maintaining existence of function*", where its measurement, in conditions far from any equilibrium steady state, "*is the magnitude of disturbance that can be absorbed before the system changes its structure by changing the variables and processes that control behavior.*" Therefore, "*ecological resilience decreases even though engineering resilience might be great*", and "*there are different stability domains in nature, [...] thus, a near-equilibrium focus seems myopic*".

Table 1 - *Definitions of resilience in ecological and social sciences (adapted from Brand & Jax, 2007).*

Categories and classes	*Definitions*	*References*
	(I) DESCRIPTIVE CONCEPT	
	(Ia) ECOLOGICAL SCIENCE	
1) original-ecological	measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables	Holling, 1973
2) extended-ecological	magnitude of disturbance that can be absorbed before the system changes its structure by changing the variables and processes that control behavior	Gunderson & Holling, 2002
	and	
	capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity	Walker et al., 2006
	2a) three characteristics: *i)* to absorb disturbances; *ii)* for self-organization; *iii)* for learning and adaptation;	Walker et al., 2002
	2b) four aspects *1)* latitude (width of the domain); *2)* resistance (height of the domain); *3)* precariousness; *4)* cross-scale relations;	Folke et al., 2004
3) systemic-heuristic	quantitative property that changes throughout ecosystem dynamics and occurs on each level of an ecosystem's hierarchy	Holling, 2001
4) operational	resilience *of* what *to* what?	Carpenter et al., 2001
	and	
	ability of the system to maintain its identity in the face of internal change and external shocks and disturbances	Cumming et al., 2005
	(Ib) SOCIAL SCIENCES	
5) sociological	ability of groups or communities to cope with external stresses and disturbances as a result of social, political, and environmental change	Adger, 2000
6) ecological-economic	transition probability between states as a function of the consumption and production activities of decision makers	Brock et al., 2002
	and	
	ability of the system to withstand either market or environmental shocks without losing the capacity to allocate resources efficiently	Perrings, 2006
	(II) HYBRID CONCEPT	
7) ecosystem-services-related	underlying capacity of an ecosystem to maintain desired ecosystem services in the face of a fluctuating environment and human use	Folke et al., 2002
8) social-ecological system		
8a) social-ecological	capacity of a social-ecological systems to absorb recurrent disturbances so as to retain essential structures, processes, feedbacks	Adger et al., 2005
8b) resilience-approach	perspective or approach to analyze social-ecological systems	Folke, 2006
	(III) NORMATIVE CONCEPT	
9) metaphoric	flexibility over the long term	Pickett et al., 2004
10) sustainability-related	maintenance of natural capital in the long run	Ott & Döring, 2004

Some years later, the concept of resilience enters sustainable hazard mitigation, thanks (among others) to the contribution of Graham A. Tobin (1999), with the aim to provide innovative policies to construct resilient communities. Assuming "*the state of Florida, USA, […] as a microcosm of […] global concerns*", Tobin conjugates ecological/socio-political approaches to build up a framework (flowchart in Figure 9), as a dynamic system, adapting three separate models: mitigation (from Waugh, 1996); recovery (from Peacock & Ragsdale, 1997); structural-cognitive (from Tobin & Montz, 1997). His "*ultimate goal is to achieve community sustainability and resilience in the face of prevailing natural and technological hazards*" and "*facilitate recovery processes*". Moreover, "*sustainable and resilient communities are defined as societies which are structurally organized to minimize the effects of disasters, and, at the same time, have the ability to recover quickly by restoring the socio-economic vitality of the community*" (quotation: Tobin, 1999).

Always in 1999, Holling and a small group of scientists/practitioners found the Resilience Alliance (RA[52]), an international multidisciplinary network that explores the dynamics of social-ecological systems. RA members "*collaborate across disciplines to advance the understanding and practical application of resilience, adaptive capacity, and transformation of societies and ecosystems in order to cope with change and support human well-being*" (quotation: RA[52]). The concept, extended to social-ecological systems, is described as 'panarchy' (Gunderson & Holling, 2002).

Starting from the work of McEntire et al. (2002; and reference therein), tracing the evolution of disaster paradigms and their drawbacks, Manyena (2006) affirms that resilience helps "*to obtain a complete understanding of risk and vulnerability*", both of them "*have not been conceptualized in a comprehensive manner*" and "*fragmentation has been common*". After giving a summary of resilience definitions, swinging between outcome and process, he concludes: "*the goal of any 'disaster resilience' programme will be to enhance the fundamental values, assets, and resources that can be applied to the process of adapting to adverse circumstances*". Furthermore, he discusses about the relationship among resilience and vulnerability, concluding in this way: "*resilience and vulnerability, although often viewed as opposites, are two distinctly separate constructs*". Finally, "*disaster resilience could be viewed as the intrinsic capacity of a system, community or society predisposed to a shock or stress to adapt and survive by changing its non-essential attributes and rebuilding itself. This definition has consequences for disaster risk reduction and development practice*" (quotation: Manyena, 2006).

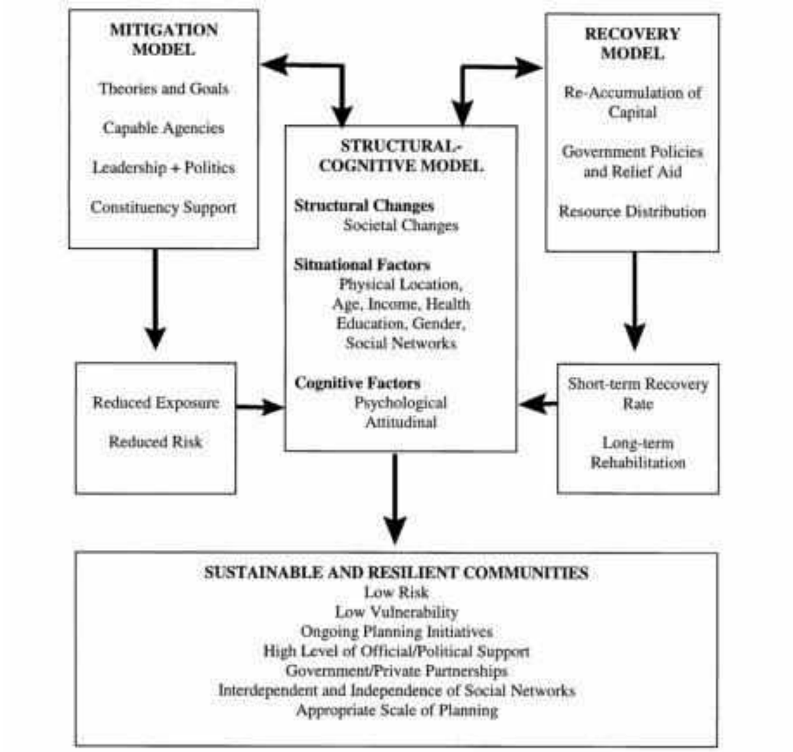


Figure 9 - *Sustainable and resilient communities in hazardous environments: a framework for analysis (Tobin, 1999, adapted from: Waugh, 1996; Peacock & Ragsdale, 1997; Tobin & Montz, 1997).*

Now important International agencies and institutions are ready to incorporate resilience in their declarations, documents and programmes. The International Federation of Red Cross and Red Crescent Societies (IFRC), the world's largest humanitarian organization founded in 1919, focuses on community resilience its World Disaster Report in 2004 (IFRC, 2004). The United Nations deliver the Hyogo Framework (UN-ISDR, United Nations-International Strategy for Disaster Reduction, 2005) one year later. In 2009, UNISDR (United Nations Office for Disaster Risk Reduction) publishes its terminology (UNISDR, 2009), including the definition of resilience ("*The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management*"). The same year, the UNISDR "Making Cities Resilient" campaign begins, addressing issues of local governance and urban risk.

It is clear that multiple cross-disciplinary transfers, among various disciplines, contribute to the polysemous concept of resilience. It is seen "*as an outcome, a state, a property or a process*". It refers to terms related one each other, but never completely overlapping; "*everyone* [pulls] *resilience towards its own meaning to adapt it to its own*" purpose. Furthermore, "*authors recall earlier concepts and rely on them, drawing some sort of circle where every term is linked to the other but without enough information to know just how they relate to one another*" (see Figure 10, Table 2; quotation: Reghezza-Zitt et al., 2012; and references therein).

In a system at risk, resilience: if a process, it should be seen in a diachronic perspective; if a property, it is a-chronic; if a quality, it can be innate or acquired (again from Reghezza-Zitt et al., 2012).

An intense debate whirls around "*change and resistance to change*" (Olsson et al., 2015). It generates two main polarized couples:

(i) *resilience vs resistance* (engineering: resilience occurs by recovering towards a previous or an improved stable state; Bruneau et al., 2003; from Cimellaro et al., 2016);

(ii) *resilience vs stability* (ecology: resilience is achieved by moving towards a different system state; Handmer & Dovers, 1996; from Cimellaro et al., 2016).

Figure 10 - *The multidisciplinary aspect of resilience (Reghezza-Zitt et al., 2012).*

In addition, another "*major point of [...] discussion in resilience circles is whether resilience is a normative concept or not*" (Olsson et al., 2015): i.e. a good, neutral or bad attribute (Olsson et al., 2015), with a varying range of application - global/local resilience - (Thorén, 2014).

Table 2 - *Synthesis of definitions/approaches of resilience (adapted from: Reghezza-Zitt et al., 2012).*

	definitions/approaches			
	Theoretical - heuristic /Practical	*Stability (equilibrium) /Persistence*	*Property /Process*	*Antonym vulnerability /Continuity or complementarity*
theoretical	Holling, 1973; Provitolo, 2012;	Pimm, 1984; Handmer & Dovers, 1996; Sheffy, 2007; O'Rourke, 2007;	Klein et al., 2003; Pelling, 2003;	Folke et al., 2002; Handmer & Dovers, 1996; UN-ISDR, 2005;
operational	Folke et al., 2002; Godschalk, 2003; UN-ISDR, 2005;	Holling, 1973, 1996; Berkes et al., 2002; Walker & Salt, 2006;	Manyena, 2006; Mc Entire et al., 2002;	Provitolo, 2012; Gallopin, 2006;
	Resistance/Adaptation	*Social/Material*	*System/Analytical*	*Positive/Neutral*
theoretical	Mileti, 1999; Alwang et al., 2001;	Mc Manus et al., 2008; Handmer & Dovers, 1996; Vale & Campanella, 2005;	Berkes et al., 2002; Carpenter et al., 2001; Gallopin, 2006;	Godschalk, 2003; Folke et al., 2002;
operational	Gordon, 1978; Comfort, 1999; Dovers & Handmer, 1992; Fiksel, 2003	Cimellaro et al., 2010a; Sheffy, 2007; O'Rourke, 2007; Bruneau et al., 2003	Cardona, 2003; Dauphiné, 2004; Mc Manus et al., 2008	Perrow, 1986; Klein et al., 2003; Comfort et al., 2010

Table 3 - *Typology of resilience definitions in ecology and social-ecological systems (Olsson et al., 2015).*

Meanings	*Attributes*			
	Descriptive-neutral (N)	*References*	*Prescriptive-good (G)*	*References*
Bounce Back (BB)	**BB-N** resilience and stability of ecological systems	Holling, 1973	**BB-G** resilience and sustainable development	Perrings, 1998
Bounce Back and Transform (BB-T)	**BB-T-N** a handful of heuristic and some propositions for understanding resilience in social-ecological systems	Walker et al., 2006	**BB-T-G** resilience thinking: integrating resilience, adaptability and transformability	Folke et al., 2010

Table 3 (adapted from Olsson et al., 2015) gives an interesting summary of these resilience definitions in ecology and social-ecological systems (SESs). Thorén & Olsson (2017; and references therein) conclude that resilience ("*definition: the ability of a system S to absorb some disturbance D whilst maintaining property P*"):

- "*should be considered […] a descriptive concept*";

- "*the assumption that resilience is a kind of natural property of systems gives the concept a sheen of scientific objectivity that is in certain contexts unwarranted or even outright dangerous*".

Evidently, in this increasing ambiguity, "*with regard to research on disasters and crises, the overlap between*" different disciplines, driving to diverse definitions of resilience (from Zhou et al., 2010; Cimellaro et al., 2016) "*has not always produced harmonious views of the same phenomena*" (from Alexander, 2013). Furthermore, "*new approaches to resilience*" look *"for new equilibrium conditions in the future than in the past [...] implementing uncertainty and adaptation*" towards the definition of a "*'ductile' resilience [...]. Accordingly to Chandler's interpretation, it could be possible to define the 'bounce-back' or 'elastic' approach as homeostatic, while the evolutionary or 'ductile' resilience can be recognized in the autopoietic one*" (from Cerè et al., 2017; Chandler & Coaffee, 2017; and reference therein).

But meanwhile, the supporters of quantitative resilience based on functionality are digging deeply, analyzing and grouping technical, organizational, social, and economic patterns (TOSE; Table 4 from: Bruneau et al., 2003; Tierney & Bruneau, 2007) of communities prone to hazards/disasters (Figure 11: NRC, 2006). The study starts from the measure of the seismic resilience, characterized by *4R*: *Robustness*, *Redundancy*, *Resourcefulness*, *Rapidity*; when an event happens, the quality of the infrastructure immediately decreases (vertical line); then, it gradually restores until normality (Figure 12; Bruneau et al., 2003).

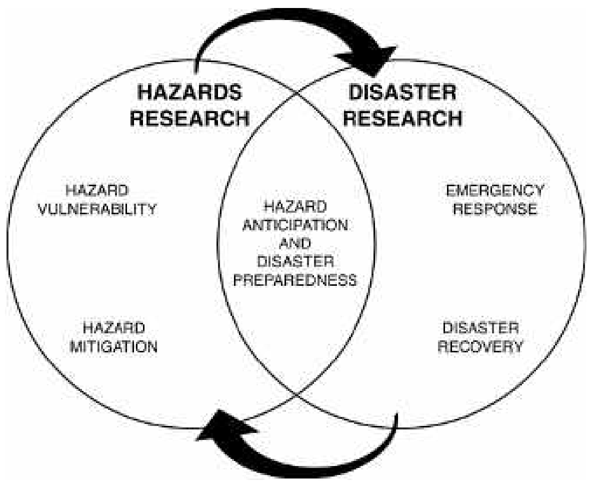
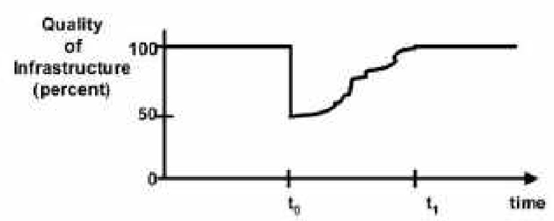


Figure 11 - *Hazards and disaster research (from NRC, 2006).*

CARRI[54] (Community and Regional Resilience Initiative) Reports (i.e. Cutter et al., 2008; Moser, 2008; Colten et al., 2008; Morrow, 2008; Gunderson, 2009; Tierney, 2009; Wilbanks, 2009; Rose, 2009; Colten & Sauer, 2010; Norris, 2010), provides a robust amount of reference materials. Resilience focuses on "*a community or region's capability to prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to public safety and health, the economy, and national security.*" For CARRI[54], the dimensions of a resilient community are: *it anticipates* problems, opportunities, and potentials for surprises; *it reduces* vulnerabilities related to development paths, socioeconomic conditions, and possible threats; *it responds* effectively, fairly, and legitimately; *it recovers* rapidly, safely, and fairly (quotations: CARRI[54]).



t_0: time instant when the hazardous event happens; $Q(t)$: quality of infrastructure in function of time.

$$R = \int_{t_0}^{t_1} [100 - Q(t)] dt$$

R: community earthquake loss of resilience (100% pre-event; reduced, as an example, to 50% immediately after the event).

Figure 12 - *Measure of seismic resilience; conceptual definition (adapted from Bruneau et al., 2003).*

Table 4: TOSE dimensions of resilience (adapted from Bruneau et al., 2003).

TOSE	*Dimensions of resilience (in case of an earthquake event)*
Technical	*The technical dimension of resilience refers to the ability of physical systems (including components, their interconnections and interactions, and entire systems) to perform to acceptable/desired levels when subject to earthquake forces.*
Organizational	*The organizational dimension of resilience refers to the capacity of organizations that manage critical facilities and have the responsibility for carrying out critical disaster-related functions to make decisions and take actions that contribute to achieving the properties of resilience outlined above, that is, that help to achieve greater robustness, redundancy, resourcefulness, and rapidity.*
Social	*The social dimension of resilience consists of measures specifically designed to lessen the extent to which earthquake-stricken communities and governmental jurisdictions suffer negative consequences due to the loss of critical services as a result of earthquakes.*
Economic	*The economic dimension of resilience refers to the capacity to reduce both direct and indirect economic losses resulting from earthquakes.*

Figure 13 (adapted from Cerè et al., 2017) gives a summary of the various methodologies used for the quantitative resilience assessment. It classifies approaches, with/without a targeted attention on specific domains, as (see Cerè et al., 2017):

(i) single-hazard;

(i_a) indirect performance-based (resilience evaluation through subjective consultations to experts, useful for a quick evaluation, but with non-negligible margins of error);

(i_b) direct expert-based (more precise, relying, for example, on fragility curves for resilience assessment at the building scale, but still with a fragmented perspective);

(ii) multi-hazard.

Hazus-MH[55] (a GIS-based software model which produces loss estimates for earthquakes, floods, hurricanes, and tsunamis, developed by the Federal Emergency Management Agency, FEMA) is situated apart in Figure 13, because "*resilience is taken into account in a non-explicit way*" and other "*geo-environmental hazards*" are considered "*as an indirect aftereffect of the primary seismic event*" (from: Cerè et al., 2017).

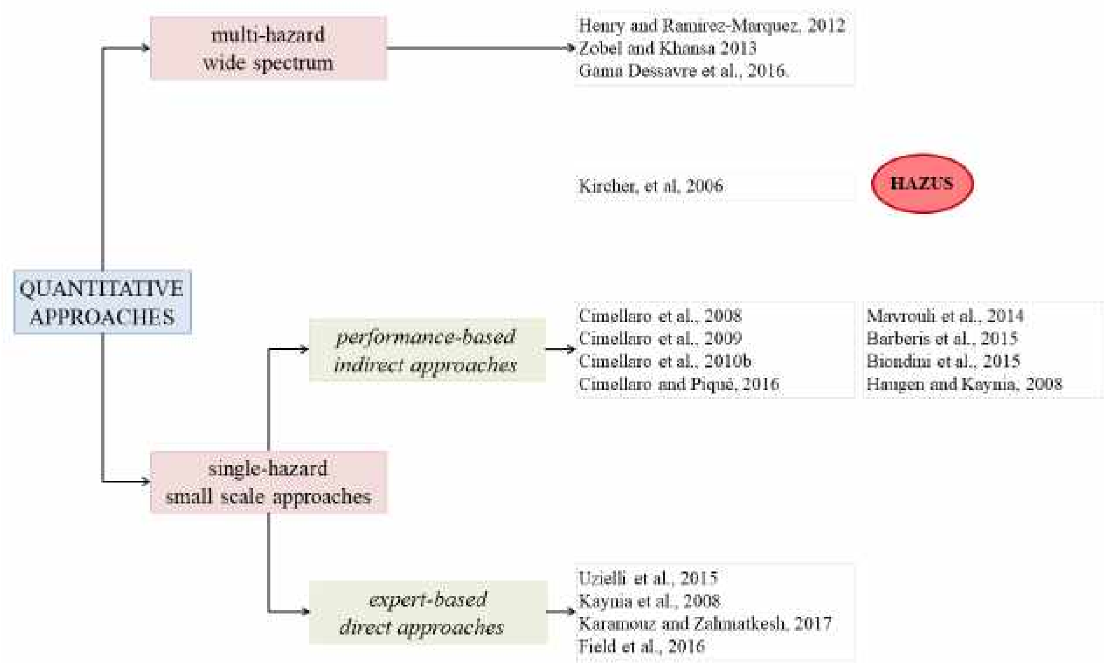


Figure 13 - *Classification of resilience quantitative approaches (adapted from Cerè et al., 2017).*

After some initial frameworks proposed by several authors (Bruneau et al., 2003; Chang & Shinozuka, 2004; Rose & Liao, 2005; Miles & Chang, 2006; Cagnan et al., 2006; see also Cimellaro et al., 2016; and references therein), "*the resilience concept as input to decision support methodologies has been applied to hospitals, lifeline structures, and cities*"; "*several methods for the quantification of infrastructures' resilience have been proposed that can be grouped in probabilistic methods, graph theory methods, fuzzy logic methods, and analytic methods*" (from: Cimellaro et al., 2016; and references therein).

Among a current wide literature, but still missing a comprehensive model quantifying resilience of communities/infrastructures, an advanced example of an interwoven framework "*to evaluate resilience […] taking into account the influence of the human behaviour, societal, organizational, and economic issues*" is given by PEOPLES, built up at MCEER (Multidisciplinary Center for Earthquake Engineering Research, University of Buffalo). PEOPLES establishes a resilience index, proposes resilience performance levels (*RPLs*) based on a finite number of parameters (Renschler et al., 2010; Cimellaro et al., 2016; Table 5), and develops "*a community hybrid model combining network models to simulate the physical infrastructures […] with agent-based models to simulate the sociotechnical networks […]. Furthermore, special attention is given to human behaviour and emotions*". In PEOPLES, the extreme earthquake scenarios are defined through probabilistic seismic hazard assessment (PSHA) and ground motion selection; only some performance indicators might be valid on a multi-hazard approach.

Table 5 - *PEOPLES framework for resilience-based design (RBD) (adapted from Renschler et al., 2010; Cimellaro et al., 2016).*

Acronym PEOPLES	*Framework groups*
P	Population and demographics
E	Environment and ecosystem
O	Organized government services
P	Physical infrastructure
L	Lifestyle and community competence
E	Economic development
S	Social-cultural capital

A heuristic effort, trying to obtain a certain consensus between different approaches in order to provide vulnerability assessment in the context of natural hazards and climate change, is given by MOVE (Methods for the Improvement of Vulnerability Assessment in Europe). It is a project sponsored by the European Commission within the framework of the FP7 programme. MOVE (Figure 14) considers four key factors: (a) exposure to a hazard or stressor; (b) susceptibility (or fragility); (c) societal response capacities or lack of resilience; (d) adaptive capacities. The framework does not provide a specific assessment method (qualitative or quantitative) or a pre-defined list of indicators; rather, it outlines key factors and different dimensions of vulnerability that can serve as a basis for a systematic operationalization of vulnerability (Birkmann et al., 2013). The framework has been already applied in several contexts (examples: Romieu et al., 2010; Papathoma-Köhle et al., 2012; Depietri et al., 2013; Papathoma-Köhle et al., 2015).

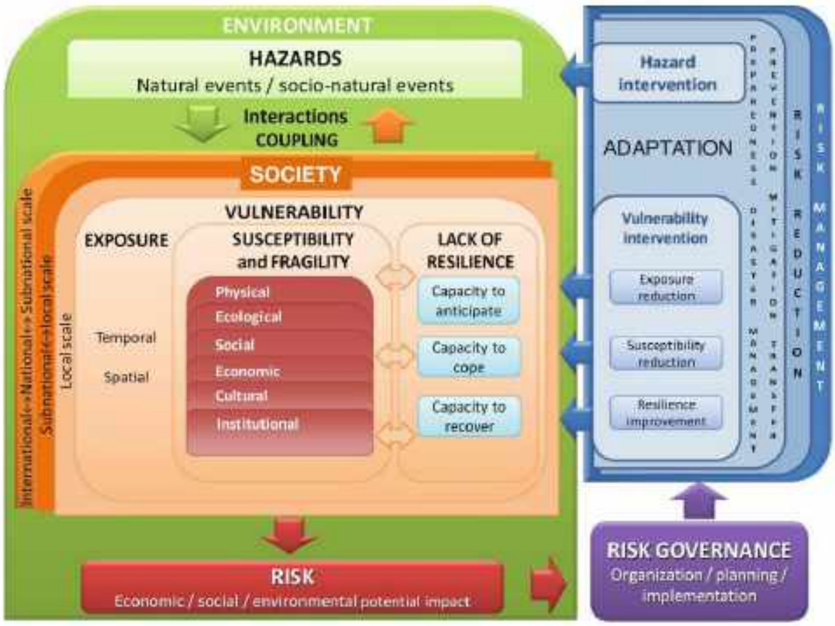


Figure 14 - *The MOVE framework (from Birkmann et al., 2013 and references therein).*

Other researches are analyzing resilience in supply chains *SCs* (a *SC* is "*a system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer*", see: Wikipedia[56]) and supply chain networks (*SCNs*), by using structured or unstructured Big Data. Big Data can be defined "*as a holistic approach to manage, process and analyse the "5 Vs (i.e. volume, variety, velocity, veracity, and value) in order to create actionable insights for sustained value delivery, measuring performance and establishing competitive advantages*" (Wamba et al., 2015). An example of "*a theoretical framework to explain* *resilience in supply chain networks for sustainability using unstructured Big Data*" is proposed by Papadopoulos et al. (2017; and references therein), applied to the context of Nepal after the April 25th, 2015 earthquake.

Far from exhausting the discussion with our contribution, and aware of the need to go beyond the use of the term resilience as a fashionable buzzword or just an attempt of a full-scale paradigm (Alexander, 2013; and references therein), we want to conclude this *excursus* introducing, in the next section, some crucial questions requiring focused insights.

2. Some open questions

2.1. System ontology and system boundaries in the definition of resilience

A structured resilience ontology is still lacking in the scientific literature. Without a solid theoretical background, the use of resilience as an integrated framework can create tensions if system ontology and system boundaries are not well defined. Starting from some widely accepted definitions of ontology (*philosophy*: the most general branch of metaphysics concerned with the state of being, its essence and existence; *computer science*: attempt of formulate an exhaustive/rigorous conceptual schema into a given domain, with artifacts providing data representation structure in terms of concepts/relations expressed through the use of logic), ontology might be considered a method of formally representing high-level knowledge as a set of concepts within a domain. More specifically, key components of a formal ontology are: classes (taxonomies), relationships, axioms, and instances (Guarino, 1998, Levine, 2014).

For scientists involved into natural disciplines, "*the system is self-organising […] and non-linear in outcomes*", where "*the effects of a simple interaction in one part of the system can produce large and complex effects in other parts of it*". "*It is the adaptive capacity of such systems […] that characterizes the*[ir] *relative resilience*" (Welsh, 2014).

On the other hand, researchers belonging to social sciences "*are reluctant to use systems as an ontological description of society*", but "*they may use 'system' analytically to study a specific aspect*" (Olsson et al., 2015). Although "*some early social system theories emanated from physics and biology*" (Olsson et al., 2015; references therein: Pareto, 1935; Parsons, 1970), "*this early view of social systems inspired by natural sciences […] is now highly controversial*" (Olsson et al., 2015; references therein: Baecker, 2001).

In sociology, Luhmann (1982), making use of the functionalist method, says that "*a social system consists of nothing but communication [...] characterized by autopoiesis, meaning that the system creates its own basic elements that make up the system*", where "*its boundaries are determined by the system itself*". Furthermore, environment and society are in Luhmann reciprocally unconnected and functionally autonomous (Olsson et al., 2015). After Luhmann, this assumption becomes less rigid, but the effort to build up a common framework is still problematic "*to justify the translation of theory and models between them*" (Welsh, 2014).

At this point of the discussion, the importance to define the system's boundaries is clear, but "*the boundaries of the social system may be considerable harder to describe than those of the ecological systems*" (Alexander, 2013). Because the description of a system "*is from the perspective of an observer*" (Collier and Cumming, 2011), theories, systems and boundaries pertinent to the definition of resilience are broadly subjective; researchers and institutions "*would treat the aspects of society and nature and their dynamics [...] differently*" (Olsson et al., 2015).

Other crucial concepts of the resilience theory in social-ecological sciences are: multiple equilibria, thresholds, feedback mechanisms, and self-organization (Olsson et al., 2015). The different approaches of homeostasis (elastic) and autopoiesis (ductile), i.e. engineering and ecological resilience (as already discussed before), put in the center the quality of the system transformations: are they oscillations around a 'bouncing-back' position (temporary altered) or an 'irreversible shift' towards a new equilibrium (without any turn back after exceeding a critical threshold)? Indeed, "*after a transition, the society, or a subsystem, operates according to new assumptions and rules, thus indicating a range of new practices and not just an altered function*" (Jerneck & Olsson, 2008).

The binary definition of feedback given in cybernetics (negative: stabilization of the system; positive: exponential change) is too simplistic if applied to social phenomena, due to its less predictability and great complexity. In fact, feedback mechanisms in social-ecological systems "*are primarily determined by [...] structured agency* [individual and collective], *rather than by structural forces*" (Olsson et al., 2015; reference therein: Davidson, 2010). Finally, also the principle of self-organization is quite debated; being unproblematic in ecology (seen as the overriding organizing principle in the resilience theory), "*in the social sciences [...] it is mainly understood as a reaction to power asymmetries and structural inequality such as the formation of social movements*" (Olsson et al., 2015; and reference therein).

2.2. *Criticism to functionalism theories*

A theoretical framework for modeling societal phenomena, based on the functionalism general theory, has been elaborated by Talcott Parsons[57] (1951; 1966; 1970; 1971). It provides a model (acronym: AGIL) with a tetradic structure ordered hierarchically (Table 6; Zwick, 2014; Olsson et al., 2015). To the Parsons' AGIL hierarchy, Gunderson & Holling (2002) prefer the neologism 'panarchy' (from the Greek god Pan, god of chaos and play) to describe the adaptive cycle model (Figure 15).

Table 6 - *AGIL scheme (Parsons, 1951; 1966; 1970; 1971); definitions taken from Olsson et al. (2015).*

A	*Adaptation* a system must adapt to the physical and social environment as well as adapt the environment to its needs
G	*Goal Attainment* a system must define and achieve its primary goals
I	*Integration* a system must coordinate and regulate interrelationships of its components and strive toward a cohesive whole
L	*Latency* a system must furnish, maintain, and renew itself and its individuals to perform their roles according to social and cultural expectations

Anyway, the resilience approaches originating from functionalism have been later criticized, being inadequate "*for overemphasizing consensus, conformity, stability, and reification*". They drives to "*a conservative approach to social change*", where "*the existence of malfunctioning institutions is difficult to explain*". If resilience is conceived as "*the equivalent of stability and harmony*", it does not take into account that "*consensus theories have declined dramatically since the 1960s […], giving more space to conflict theory and issues of diversity, inequality, and power*" (Olsson et al., 2015; and references therein). Therefore, a static concept of resilience can justify and endorse (consciously or not) "*particular policies, projects, and practices […] increasily adopted by influential global organizations such as the United Nations Development Program and funding institutions such as the Rockfeller Foundation as a basis for policy-making and deployment of funds*" (Olsson et al., 2015; and references therein). A similar attitude seems to be also adopted by the European Commission in the framework of recent research programmes.

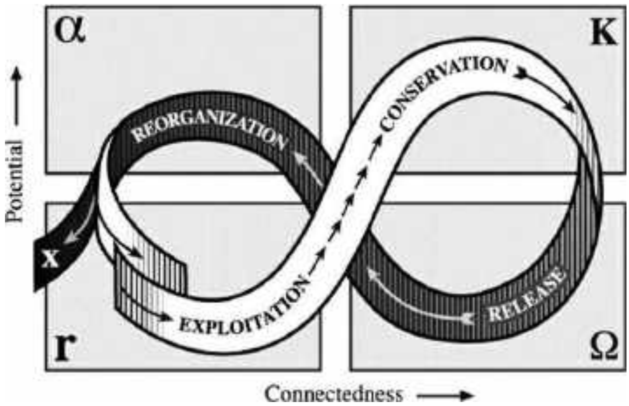


Figure 15 - *Panarchy adaptive cycle, with a stylized representation of the four ecosystem functions r, K, Ω, α and the flow events among them (from Gunderson and Holling, 2002).*

2.3. Underestimation of key factors in disaster risk reduction

As a consequence of the above said point, official provisions of International Agencies (UN-ISDR, 2005; UNISDR, 2012; UNDRR, 2015) should be updated, putting in place "*new arrangements* [with] *a period of consultation during which suggestions and observations* [are helpful to] *identify five 'priorities for action'* ", as specified below by Alexander & Davis (2012; and references therein):
- the human right to hazard information;
- explosive population growth;
- corruption;
- how people are placed at risk by the actions of governments;
- discrimination against women.

This effort is fundamental to fill the existing gap, highlighted by researchers belonging to social sciences/humanities, in the definition of resilience, and *"to challenge publicly any social, economic, political, religious or cultural obstacles to risk reduction*" (Alexander & Davis, 2012).

3. Final remarks

After my personal flight over the historical evolution of the resilience concept (summary in Figure 16), stimulated by the reading of the Alexander's work (2013), I tried to point out some open questions about the different approaches to resilience across various disciplines, analyzing a huge amount

(but non exhaustive, of course) of scientific literature. Four leading threads can be pulled out from the mess:
(i) first, originating from the early Rankine's and later Bruneau formulations, several methods for the quantification of the 'engineering resilience', with special focus on structural and infrastructural domains, have been implemented, until to very articulated networks; this 'bounce-back' or 'elastic' approach (oscillations around a steady state) can be considered as '*homeostatic*';
(ii) second, the 'ecological resilience', commonly used in this field after Holling and colleagues of Resilience Alliance (RA), regards a possible 'irreversible shift' towards a new equilibrium, i.e. with a 'ductile' or '*autopoietic*' essence;
(iii) third, resilience does not currently engage the core of social sciences, where functionalism (and subsequent neofunctionalism) models are judged inadequate, with conflict theories gaining more audience; thus, increasing popularity but still scarce unification depict the situation, where resilience still necessitates a robust effort of further multi-, inter-, trans-disciplinary research, going beyond the current fragmentation;
(iv) four, impressive tools supplied by Geomatics/Big Data management and extraordinary potentialities available from complex mathematical models give us now the opportunity to create 'a network of networks'.
Anyway, the fast run of technology cannot be separated by a slower and shared '*Peripatetiké Scholé*' (Περιπατητική Σχολή), exploring philosophical and scientific theories with a pluralistic but holistic view.

At this point of the discussion, a proposal of a rigid frame regarding the resilience concept is far from my purpose. Hence, I only suggest some nuclei of future research (Table 7) that might be exploited in future studies. Furthermore, the presence of the concept of resilience, coming from other cultures and countries worldwide, should be more extensively investigated; to this goal, additional contributions are strongly encouraged.

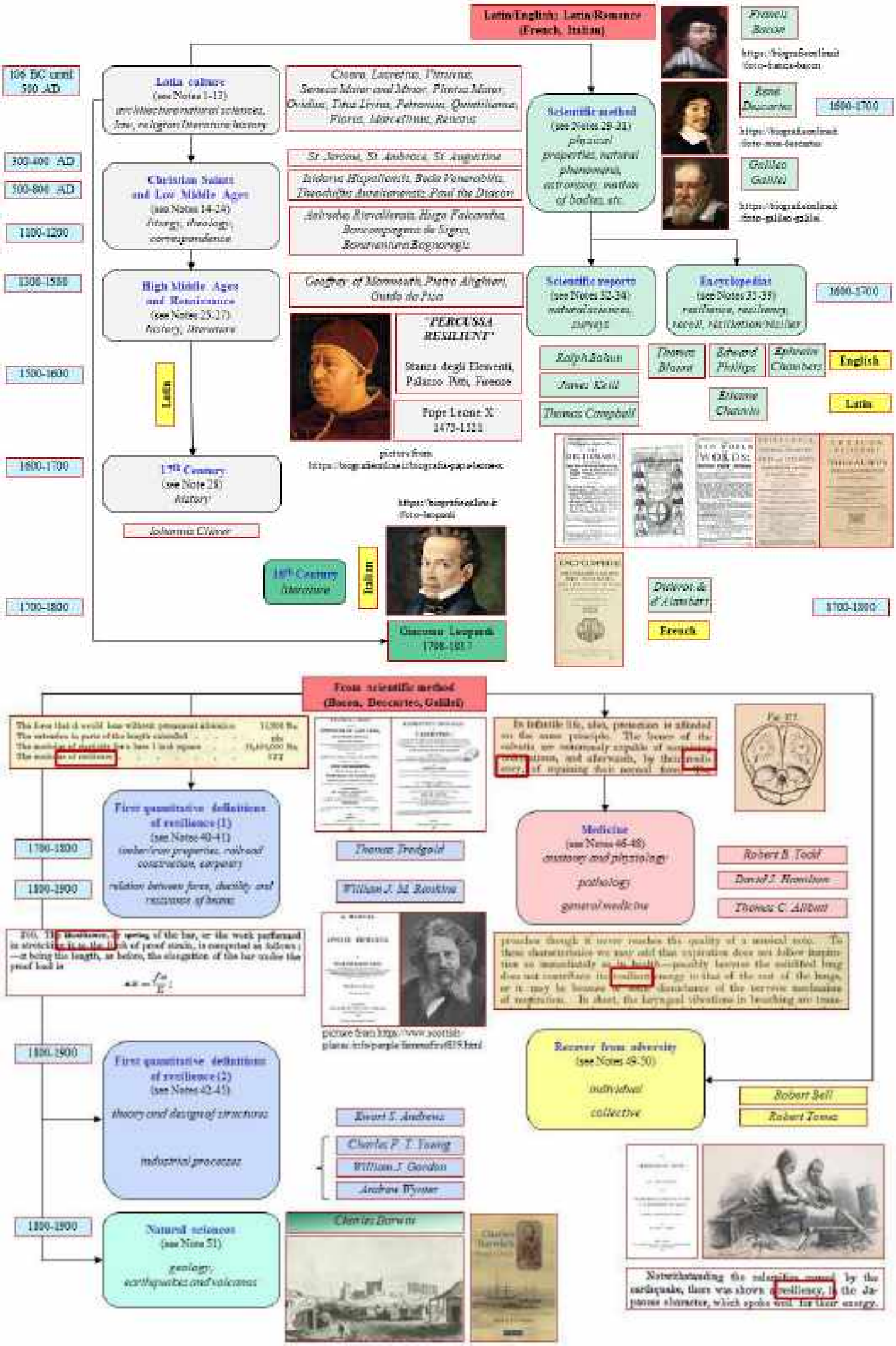


Figure 16a - *Evolution of resilience; from the classic age to the end of 19th century.*

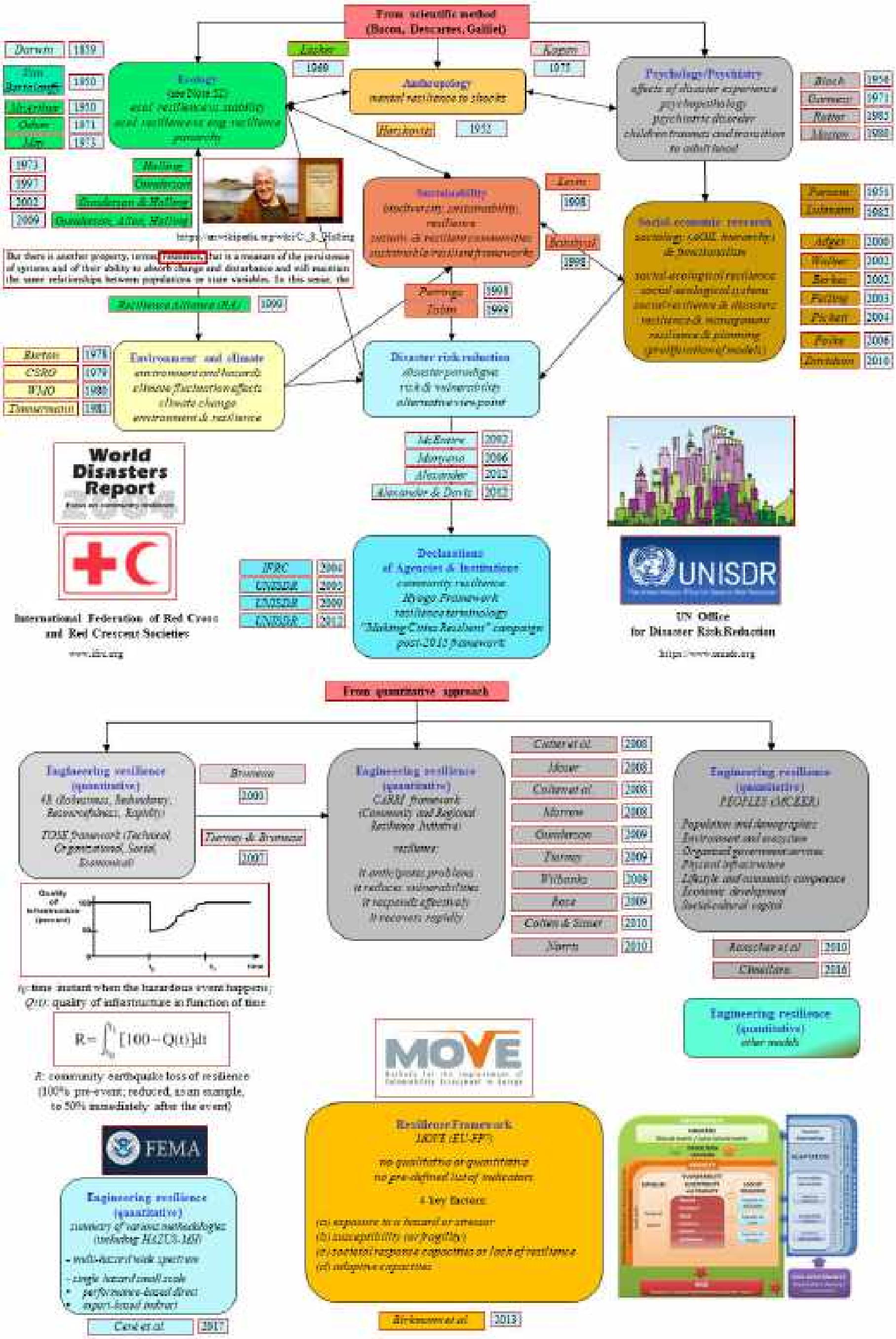


Figure 16b - *Evolution of resilience; from the 20th century until today.*

Table 7: nuclei for a pluralistic but holistic view of resilience.

attributes	description	target
safety	*protection of life, heritage, assets from natural/human-made disasters across climate/social changes*	*multi-hazard combinations and maps*
robustness	*adequacy of structural/infrastructural systems to withstand actions related to their function/exposure*	*multilevel networks*
adaptive capacity	*ability to respond successfully to new changes and recovery with acceptable consequences after catastrophic events*	*social-ecological models*
sustainability	*maintaining the natural/anthropogenic capital and fostering mature self-balanced environments*	*sustainability models*
governance	*consensual and shared management of conflicts towards a new equilibrium before/throughout/after traumas/disasters*	*risk management*
anamnesis	*safe-guarding and transmitting collective memory and cultural identity intact to posterity as a drop anchor for democracy*	*preservation of tangible/intangible heritage*

Notes

[1]Marcus Vitruvius Pollio (ca. 80-70 BC; after ca. 15 BC), *De Architectura*; *Liber V, Caput Octavum*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from: http://www.documentacatholicaomnia.eu/03d/-075_-025,_Vitruvius_Pollio._Marcus,_De_Architectura,_LT.pdf;
Fig. 1: last access May 14, 2019; head picture from: https://www.azquotes.com/author/38395-Marcus_Vitruvius_Pollio;
Fig. 1: last access May 14, 2019; book cover "*De Architectura*" from: https://www.gonnelli.it/it/asta-0019/vitruvius-marcus-pollio-de-architectura-libri-.asp; last access May 14, 2019.

[2]Titus Lucretius Carus (94 BC; 50 or 55 BC), *De Rerum Natura*; *Liber I and IV*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from: http://www.documentacatholicaomnia.eu/03d/-099_-055,_Lucretius_Carus._Titus,_De_Rerum_Natura,_LT.pdf;
Fig. 1: last access May 14, 2019; head picture from: https://www.iep.utm.edu/lucretiu/;
Fig. 1: last access May 14, 2019; book cover from: https://www.europeana.eu/portal/it/record/9200332/ABO__2BZ179263303.html.

[3]Gaius Plinius Secundus Maior (23 or 24 AD; 79 AD), *Naturalis Historia*; *Liber IX 71*; *Liber XI 39*; *Liber XXII 31*; Penelope, Uchicago.edu. Last access May 14, 2019 from: http://penelope.uchicago.edu/Thayer/E/Roman/Texts/Pliny_the_Elder/home.html; last access May 14, 2019.
Fig. 1: last access May 14, 2019; head picture from: https://www.pinterest.it/pin/473018767096769934/;
Fig. 1: last access May 14, 2019; book cover from: https://www.taccuinistorici.it/ita/news/antica/letteratura/Naturalis-historia-Plinio-il-Vecchio.html.

[4]Lucius Annaeus Seneca Maior (ca. 54 BC; ca. 39 AD), *Controversiae*; *Liber 1, Casus III*, *Incesta Saxo Deiciatur*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:

http://www.documentacatholicaomnia.eu/03d/-054_0039,_Seneca_maior._Lucius_Annaeus,_Controversiae,_LT.pdf;
Fig. 1: last access May 14, 2019; head picture from:
https://www.bookdepository.com/Letters-from-Stoic-Seneca/9780140442106;
Fig. 1: last access May 14, 2019; book cover from:
https://www.abebooks.it/ricerca-libro/titolo/l-annaei-senecae-philosophi-opera-omnia/autore/seneca/sortby/1/.

[5a]Lucius Annaeus Seneca Minor (ca. 4 BC; 65 AD), *De Ira*; *Liber III, V*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/-004_0065,_Seneca_minor._Lucius_Annaeus,_De_Ira,_LT.pdf.

[5b]Lucius Annaeus Seneca Minor (ca. 4 BC; 65 AD), *Epistulae Morales ad Lucilium*; *Liber X, LXXXII, 6*; *Liber XIV*; *Liber XV*; *Liber XIV et XV, XCV, 48*; *Liber XX, CXXII, 1*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/-004_0065,_Seneca_minor._Lucius_Annaeus,_Epistulae_Morales_ad_Lucilium,_LT.pdf.

[6]Publius Ovidius Naso (43 BC; 17 AD), *Metamorphoses*; *Liber III 677*; *Liber VI 374*; *Liber XII 480*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/-043_0017,_Ovidius_Naso._Publius,_Metamorphoses,_LT.pdf;
Fig. 1: last access May 14, 2019; head picture from:
http://www.succedeoggi.it/2017/09/la-voce-ovidio/; last access May 14, 2019.
Fig. 1: last access May 14, 2019; book cover from:
https://genius.com/Ovid-the-metamorphoses-of-ovid-book-i-fable-1-annotated; last access May 14, 2019.

[7]Marcus Tullius Cicero (106 BC; 43 BC), *Pro Roscio Armerino*; *79*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/-106_-043,_Cicero._Marcus_Tullius,_Pro_Roscio_Amerino,_LT.pdf;
Fig. 1: last access May 14, 2019; head picture from:
https://biografieonline.it/biografia-marco-tullio-cicerone;
Fig. 1: last access May 14, 2019; book cover from:
https://www.booklooker.de/Bücher/Marcus-Tullius-Cicero+Pro-Sex-Roscio-Amerino-Heidelberger-Texte-Band-15/id/A01wxn9E01ZZR.

[8]Titus Livius (59 BC; 17 AD), *Ab Urbe Condita*; *Liber XXX, 33*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/-059_0017,_Livius._Titus,_Ab_Urbe_Condita,_LT.pdf;
Fig. 1: last access May 14, 2019; head picture from:
https://www.controcampus.it/2014/06/tito-livio-padova-unipd-centro-ricerca/;
Fig. 1: last access May 14, 2019; book cover from:
https://www.gonnelli.it/it/asta-0015-2/livius-titus-historiarum-ab-urbe-condita-libri.asp.

[9]Marcus Fabius Quintilianus (ca. 35-40 AD; 96 AD), *Istitutio Oratoria*; *Liber XII, 10.LVI*; the Latin Library. Last access May 14, 2019 from:
http://www.thelatinlibrary.com/quintilian/quintilian.institutio12.shtml#1; last access May 14, 2019.
[10]Lucius Enneus Florus (74 AD; ca. 130 AD), *Epitomae de Tito Livio Bellorum Omnium*; *Liber I XLI*; *Liber II XXI*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/0000-0100,_Florus._Lucius_Enneus,_Epitomae_de_Tito_Livio_Bellorum_Omnium,_LT.pdf.
[11]Gaius Petronius Arbiter (ca. 27 AD; 66 AD), *Satiricon*; *XLVI and LXXXIX*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/0027-0066,_Petronius._Caius,_Satiricon,_LT.pdf;
Fig. 1: last access May 14, 2019; head picture from:
https://www.romanoimpero.com/2010/09/petronius-arbiter.html; last access May 14, 2019.
Fig. 1: last access May 14, 2019; book cover from:
https://www.pinterest.it/pin/327214729153742218; last access May 14, 2019.
[12]Ammianus Marcellinus (ca. 325-330 AD; after 391 AD), *Rerum Gestarum Libri XXXI, Liber XXIV, IV, 15*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/0325-0378,_Ammianus_Marcellinus,_Rerum_Gestarum_Libri_XXXI,_LT.pdf.
[13]Flavius Vegetius Renatus (second half 4th century; 5th century), *Epitoma Rei Militaris, Liber II, XXIII*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Antiqua Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/0300-0400,_Vegetius_Renatus._Flavius,_Epitoma_Rei_Militaris,_LT.pdf.
[14]Sofronius Eusebius Hieronimus (St. Jerome, ca. 347-420; Saint, Presbyterian, Monk, Doctor of the Church), *Epistolae Secundum Ordinem Temporum Distributae, Epistola ad Nepotianum Presbyterum, 52.14*; Collectio Documenta Catholica Omnia, Tabulinum De Ecclesiae Patribus Doctoribusque, Materia Migne JP, Argumentum Patrologia Latina. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/02m/0347-0420,_Hieronymus,_Epistolae_Secundum_Ordinem_Temporum_Distributae,_MLT.pdf.
As reported by Alexander (2013), "… the meaning was strongly perpetuated in the proverbs of St. Jerome …", see *Divina Bibliotheca 18, Liber Masloth Qui Dicitur Liber Proverbiorum*; Collectio Documenta Catholica Omnia, Tabulinum De Ecclesiae Patribus Doctoribusque, Materia Migne JP, Argumentum Patrologia Latina. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/02m/0347-0420,_Hieronymus,_Divina_Bibliotheca_18._Liber_Masloth_Qui_Dicitur_Liber_Proverbiorum,_MLT.pdf.
[15]Ambrosius Mediolanensis (St. Ambrose, ca. 340-397; Saint, Doctor of the Church, Archbishop of Milan, one of the most influential ecclesiastical personalities of the 4th century), *Sanctii Ambrosii Mediolanensis Episcopi et Ecclesiae Doctoris Hexameron Libri Sex*; *Liber Tertius, CAPUT IX 40*; Collectio Documenta Catholica Omnia, Tabulinum De

Ecclesiae Patribus Doctoribusque, Materia Ecclesiae Patres Latini, Argumentum Ambrosius Mediolanensis, Sanctus. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/0339-0397,_Ambrosius,_Hexameron_Libri_Sex,_LT.pdf.
[16]Aurelius Augustinus Hipponiensis (St. Augustine, 354-430; Saint, influent Christian theologian, philosopher), *Breviculus collationis cum Donatistis*; *Collatio primi diei*, *CAPUT X*; *Collatio tertii diei*, *CAPUT III 3*; *Collatio tertii diei*, *CAPUT XIX.37*; Collectio Documenta Catholica Omnia, Tabulinum De Ecclesiae Patribus Doctoribusque, Materia Migne JP, Argumentum Patrologia Latina. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/02m/0354-0430,_Augustinus,_Breviculus_Collationis_Cum_Donatistis,_MLT.pdf.
[17]Paulus Diaconus Warnefred Barnefridus Cassinensis (Paul the Deacon, ca. 720-799; Benedictine monk, scribe, historian of the Lombards), *Historia Langobardorum*; *Liber I.6*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Medioaevali Aetate, Argumentum 20 De Historia. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/0720-0800,_Paulus_Diaconus,_Historia_Langobardorum,_LT.pdf.
[18]Bonaventura Bagnoregis (Bonaventure, 1221-1274; Saint, Italian medieval Franciscan, scholastic theologian, philosopher, author of the life of St. Francis), *Legenda Maior Sancti Francisci*; *CAPUT IV, De Profectu Ordinis sub manu ipsus et confirmatione regulae prius approbatae*, *1*,*7*; Collectio Documenta Catholica Omnia, Tabulinum De Ecclesiae Patribus Doctoribusque, Materia Ecclesiae Doctores, Argumentum Bonaventura Bagnoregis, Sanctus. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/1221-1274,_Bonaventura,_Legenda_Major_Sancti_Francisci,_LT.pdf.
[19]Isidorus Hispaliensis (560-636), *Etymologiarum Sive Originum*; *Liber XI*, *De homine et portentis*, *I. De homine et partibus eius*, *[81]*; *Liber XII*, *De animalibus*, *II. De bestiis, [9]*; *Liber XIII*, *De mundo et partibus*, *XIX. De lacis et stagnis*, *[3]*; *Liber XVIII*, *De bello et ludis*, *I. De bellis*, *[11]*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Medioaevali Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/0560-0636,_Isidorus_Hispaliensis,_Etymologiarum_Sive_Originum_Libri_XX_%5B1%5D,_LT.pdf.
[20]Beda Venerabilis (627-735 AD), *Historia ecclesiastica gentis Anglorum*; *Liber V [12]*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Medioaevali Aetate, Argumentum 20 De Historia. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/0627-0735,_Beda_Venerabilis,_Historiam_Ecclesiasticam_Gentis_Anglorum,_LT.pdf.
[21]Theodulfus Aurelianensis (750-821), *Carmina*; *Liber Primus*, *[0296A]*; *Liber Quintus*, *[0351D]*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Medioaevali Aetate, Argumentum 30 De Humanitate. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/0750-0821,_Theodulfus_Aurelianensis,_Carmina,_LT.doc.
[22]Aelredus Rievallensis (1110-1167), *De Amicitia*; *CAPUT XXII, Patientia*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Medioaevali Aetate, Argumentum 10 De Philosophia. Last access May 14, 2019 from:

http://www.documentacatholicaomnia.eu/03d/1110-1167,_Aelredus_Rievallensis,_De_Amicitia,_LT.pdf.

[23]Hugo Falcandus (1150-1250), *Liber de Regno Siciliae*; *XIII, De Matheo Bonello et qualiter occidit Maionem*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Medioaevali Aetate, Argumentum 20 De Historia. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/1150-1250,_Falcandus._Hugo,_Liber_de_Regno_Siciliae,_LT.pdf.

[24]Boncompagnus de Signa (1165-1240), *Boncompagnus*; *1.11 De contrariis eventibus, qui scolaribus in primordio itineris occurrunt*, *1.11.1 De illo, qui significat evidens impedimentum, quod sibi occurrit, dum iret ad scolas. Unde querit consilium, quid ei sit agendum [1]*; *1.20 De subsidiis postulandis, 1.20.7 Littere speciales ad fratres cum variatione regulari, [1]*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Medioaevali Aetate, Argumentum 10 De Philosophia. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/1165-1240,_Boncompagnus_de_Signa,_Boncompagnus,_LT.pdf.

[25]Geoffrey of Monmouth (Galfridus Monumotensis, Geoffrey of Monmouth; ca. 1100-1155; Welsh cleric), *Historia Regum Britannie*; *Liber Primus, 12*; Medieval Academy. Last access May 14, 2019 from:
http://www.medievalacademy.org/resource/resmgr/maa_books_online/hammer_0057.htm.

[26]Pietro Alighieri (1300-1364; son of Dante and Gemma Donati; magistrate and Italian literature critic), *Comentum super poema Comedie Dantis*; *Super V capitulo Paradisi, vv. 1-84*; Biblioteca Italiana. Last access May 14, 2019 from:
http://ww2.bibliotecaitaliana.it/xtf/view?docId=bibit000160/bibit000160.xml&chunk.id=d3352e12757&toc.id=&brand=bibit.

[27]Guido da Pisa (second half-13rd century; first half-14th century; Monk and Italian writer), *Expositiones et glose super Comediam Dantis*; *Inferno, XXI, vv. 19-21*; Biblioteca Italiana. Last access May 14, 2019 from:
http://ww2.bibliotecaitaliana.it/xtf/view?docId=bibit001498/bibit001498.xml&chunk.id=d6730e18043&toc.depth=1&toc.id=d6730e17931&brand=newlook.

[28]Johannes Cluverus (Iohannis Clüver, 1593-1633; German academic, theologist), *Historiarum Totius Mundi Epitome; Martianus, 325 (p. 203)*; *Irene, Costantinus VI. Porphyrogenitus, Nicephorus, Byzantini: Carolus Magnus Romanus Imper, 370 (p. 231)*; *Maximilianus I. Romanorum Imp. Baiazetes II, et Selimus I, Turcae, 585 (p. 364)*; *Ioan. Cluv. Epistomes Historiarum Continuatio, 893 (p. 553)*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Renascentali Aetate, Argumentum 20 De Historia. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/1667-1667,_Cluverius_Ioannes,_Historiarum_Totius_Mundi_Epitome,_LT.doc.

[29a]Franciscus Baconus de Verulamio (Francis Bacon; 1561-1626; English philosopher, statesman, scientist, jurist, orator, essayist; he served both as Attorney General and Lord Chancellor of England), *Novum Organum*; *XIII, Tabula Graduum sive Comparativae in Calido, 29*; *XIII, Tabula Graduum sive Comparativae in Calido, 36*; *XXV*; *XXXVI, 5*; *XLVIII, 3*; *XLVIII, 4*; *L, 2*; *L, 3*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Renascentali Aetate, Argumentum 20 De Historia. Last access May 14, 2019 from:

http://www.documentacatholicaomnia.eu/03d/1561-1626,_Bacon._Franciscus,_Novum_Organum,_LT.pdf.

[29b]Franciscus Baconus de Verulamio (Francis Bacon; 1561-1626; English philosopher, statesman, scientist, jurist, orator, essayist; he served both as Attorney General and Lord Chancellor of England), *Sylva Sylvarum, Sive Historia Naturalis in decem Centurias distribute*; *245 (pp. 90-91)*; ECHO-Cultural Heritage Online. Last access (text and figures) May 14, 2019 from:
http://echo.mpiwg-berlin.mpg.de/ECHOdocuView?start=221&viewMode=text&viewLayer=search&url=%2Fpermanent%2Flibrary%2FWX8HY2V2%2Findex.meta&query%20=resil&queryType=fulltextMorph&pn=90.
http://echo.mpiwg-berlin.mpg.de/ECHOdocuView?start=221&viewMode=text&viewLayer=search&url=%2Fpermanent%2Flibrary%2FWX8HY2V2%2Findex.meta&query%20=resil&queryType=fulltextMorph&pn=91.

[29c]Franciscus Baconus de Verulamio, *Sermones Fideles sive Interiora Rerum*; *XXIX, De proferendis finibus imperii, 14*; Collectio Documenta Catholica Omnia, Tabulinum De Rebus Laicorum, Materia De Renascentali Aetate, Argumentum 20 De Historia. Last access May 14, 2019 from:
http://www.documentacatholicaomnia.eu/03d/1561-1626,_Bacon._Franciscus,_Sermones_Fideles_Sive_Interiora_Rerum,_LT.pdf.

[30]René Descartes (René Descartes, 1596-1650; French philosopher, mathematician, scientist), *Oeuvres de Descartes*, *Correspondance Avril 1622-Février 1638*; publiées par Charles Adam & Paul Tannery sous les auspices du Ministère de l'Instruction Publique, Paris, Léopold Cerf, imprimeur-éditeur, 12, Rue Sainte-Anne, 1897.
Descartes a Mersenne, 25 Février 1630, lettre 110, p. 117, 6-19 (in French). Last access May 14, 2019 from:
https://archive.org/download/uvresdedescartes01desc/uvresdedescartes01desc.pdf;
Translation into Latin, Epistolae: Partim ab Auctore Latino sermone conscriptae, partim ex Gallico translatae, *pars secunda, AMSTELODAMI, Apud Danielem Elzevirium, cIↄ Iↄc LXVIII; Epistola CX Ad R.P. Mersennum, p. 370*. Last access May 14, 2019 from:
https://books.google.it/books?id=bjFZAAAAcAAJ&pg=PA370&lpg=PA370&dq=Observandum+tamen+est+praeterea+non+modo&source=bl&ots=VwXpJt4-VC&sig=NMFMhzdiFyr0ke-LEpgVG2WwDCY&hl=it&sa=X&ved=0ahUKEwi8lfjJgNzJAhUCQBQKHTlcABMQ6AEIHjAA#v=onepage&q=Observandum%20tamen%20est%20praeterea%20non%20modo&f=false.

[31]Galileo Galilei (1564-1642; Italian astronomer, physicist, engineer, philosopher). Although he seems ignore the term, it appears in Latin writings of colleagues involved in epistolary exchanges or debates with him about Astronomy and motion of bodies. Examples:
- Honoratus Fabrius or Honoré Fabri (1608-1688, French Jesuit theologian, mathematician, physicist, Court Official, Ecclesiastic Official), *Tractatus Physicus De Motu Locali*: *In Quo Effectus Omnes, Qui Ad Impetum, Motum naturalem, violentum, & mixtum pertinent, explicantur, & ex principiis Physicis demonstrantur*; *Liber Secundus, De Motu Naturali, Theorema 61, Corollarium 7, Dissertatio, De Motu naturaliter accelerato (p. 102)*; *Liber Secundus, De Motu Naturali, Theorema 100 (p. 123)*; *Liber Secundus, De Motu Naturaliter Accelerato, Theorema 123 (p. 130)*; *Liber Sextus, De Motu Reflexo, Theorema 55 (p. 254)*; *Liber Sextus, De Motu Reflexo, Theorema 56 (p. 254)*; *Liber Sextus, De Motu Reflexo,*

Theorema 75 (p. 261); *Liber Sextus, De Motu Reflexo, Theorema 86 (p. 264)*; *Liber Sextus, De Motu Reflexo, Theorema 92 (p. 266)*; *Liber Sextus, De Motu Reflexo, Scholium (p. 267)*; *Liber Septimus, De Motu Circulari, Theorema 8 (p. 275)*; *Liber Nonus, De Motu Mixto et Recto, et Circulari, vel ex pluribus Circularibus, Theorema 29 (p. 369)*; *Liber Nonus, De Motu Mixto et Recto, et Circulari, vel ex pluribus Circularibus, Theorema 13 (p. 372)*; *Liber Decimus, De Diversis Motionum, vel imprimendi motus rationibus, Theorema 6 (p. 388).* Auctore Petro Mousnerio Doctore Medico, cuncta excepta ex praelectionibus R.P. Honorati Fabry, Societatis Iesu, Lyon, apud Ioannem Champion in foro Cambij, 1646. Last access May 14, 2019 from:
http://reader.digitale-sammlungen.de/resolve/display/bsb10052837.html.
- Fortunio Liceti (1577-1657, Italian physician, philosopher, scientist), *Liteosphoros, seu de Lapide Bononiensi*; *Caput Quinquagesimum, De Luna subobscura luce prope conjunctiones, et in deliquiis observata, Digressio physico-matematica (2) (p. 185)*; in "*Le opere di Galileo Galilei*"; Prima Edizione Completa condotta sugli autentici Scritti Palatini e dedicata a S.A.I. e R. Leopoldo II, Granduca di Toscana, Tomo III, Firenze, Società Editrice Fiorentina, 1843. Last access May 14, 2019 from:
https://books.google.it/books?id=HszkNFtmY8kC&pg=PA185&lpg=PA185&dq=galileus+resilire&source=bl&ots=Y_850Hd0aL&sig=2te3ZFE6SQB-jL6MKah3scZHq-A&hl=it&sa=X&ved=0ahUKEwiqx_vvxt3JAhXL8RQKHbwqAo4Q6AEIHDAA#v=onepage&q=galileus%20resilire&f=false.

[32]Ralph Bohun (1639-1716; Church of England clergyman, fellow of New College, Oxford, rector of West Kington, Wiltshire, later prebendary of Salisbury Cathedral), *A Discourse concerning the origine and properties of wind. With an Historical Account of Hurricanes, and other Tempestuous winds (*Bohun, 1671), pp. 9-10. Last access (text and figures) May 14, 2019 from:
https://books.google.it/books?id=oD8sAQAAMAAJ&printsec=frontcover&hl=it&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false.

[33]James Keill (1673-1719; Scottish physician, philosopher, medical writer, translator, early proponent of mathematical methods in physiology), *An Account of Animal Secretion, The Quantity of Blood In the Humane Body, Muscular Motion* (Keill, 1708), I. Of Animal Secretion. Prop. X, pp.21-22. Last access (text and figures) May 14, 2019 from:
https://archive.org/download/accountofanimals00keil/accountofanimals00keil.pdf.

[34]Thomas Campbell (1733-1795; Irish Church Protestant clergyman, traveler), *A Philosophical Survey of the South of Ireland, in a series of letters to John Watkinson* (Campbell, 1778), p.144. Last access (text and figures) May 14, 2019 from:
http://catalog.hathitrust.org/Record/008399932.

[35]Thomas Blount (1618-1679; Roman Catholic lawyer, antiquarian, lexicographer), *Glossographia or a dictionary, interpreting all such hard words, RE* (Blount, 1656). Various editions since 1656 (first). Last access (text and figures) May 14, 2019 from:
https://archive.org/details/glossographiaan00blougoog.

[36]Edward Phillips (1630-1696; English encyclopedist; Phillips, 1658), *The New World of English Words, or, a General Dictionary, RE* (Phillips, 1658). Last access (text and figures) May 14, 2019 from:
https://archive.org/download/The_New_World_of_English_Words_Or_A_General_Dictionary.

[37]Ephraim Chambers (1680-1740; English encyclopedist; Chambers, 1728), *Cyclopaedia, or, an Universal Dictionary of Arts and Sciences, REC* (Chambers, 1728). Various editions since 1728 (first). Last access (text and figures) May 14, 2019 from:

https://archive.org/details/Cyclopediachambers-Volume1;
https://archive.org/details/Cyclopediachambers-Volume2.

[38]Stephanus Chauvin (Étienne Chauvin; 1640-1725; French Protestant, after the Edict of Nantes retired to Rotterdam, preacher at the Walloon church; in 1695, the elector of Brandenburg appointed him pastor and philosophy professor; later inspector of the French college at Berlin, enjoying considerable reputation as a representative of Cartesianism and student of physics), *Lexicon Rationale Sive Thesaurus Philosophicus Ordine Alphabetico digestus, RES* (Chauvin, 1692). Last access (text and figures) May 14, 2019 from:
https://www.e-rara.ch/zut/doi/10.3931/e-rara-15278;

[39]Denis Diderot (1713-1784; French philosopher, art critic, writer) & Jean Baptiste Le Rond d'Alambert (1717-1783; French mathematician, mechanician, physicist, philosopher, music theorist), *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des mètiers, par une societé de gens de lettres. Tome Quatorzieme, REGGI=SEM, p. 172, Resiliation, Resilier*. Last access May 14, 2019 from:
https://archive.org/details/encyclopdieoud14alem/page/n6.

[40a]Thomas Tredgold (1788-1829; English engineer, known for his early work on railroad construction), *Practical essay on the strength of cast iron, and other metals*; *Section V, An account of some experiments on the resistance of cast iron, pp. 60-67; Section XI, Of strength of cast iron to resist an impulsive force, pp.191-195; Table of data, Properties of materials, pp. 215-218* (Tredgold, 1824). London: John Weale, 59, High Holborn, 1860-1. Last access May 14, 2019 from:
https://archive.org/details/practicalessayon00tredrich/page/n4.

[40b]Thomas Tredgold (1788-1829; English engineer, known for his early work on railroad construction), *Elementary Principles of Carpentry; Section II, Of resistance of timber, p. 112; Section XII, Timber, p. 472; Tables, Table No. XIX, p. 499* (Tredgold, 1853). London: E&F. N. Spon, 48, Charing Cross, New York: 446, Broome Street, 1875. Last access May 14, 2019 from:
https://archive.org/details/elementaryprinci00treduoft/page/n2.

[41]William John Macquorn Rankine (1820 -1872; Scottish mechanical and civil engineer, physicist, mathematician, founding contributor to thermodynamics with Rudolf Clausius and William Thomson 'Lord Kelvin'), *A Manual of Applied Mechanics; Part II Theory of Structures, Chapter III Strength and Stiffness, Section 1 Summary of General Principles, 244. Ultimate strength, p. 273; Part II Theory of Structures, Chapter III Strength and Stiffness, Section 3 On Resistance to Stretching and Tearing, 266. Resistance or spring of the bar, p. 287; Part II, Theory of Structures, Chapter III, Strength and Stiffness, Section 6 On Resistance to Bending and Cross-Breaking, 305. Resilience or Spring of a Beam, pp. 330-332; Part II Theory of Structures, Chapter III Strength and Stiffness, Section 7 On Resistance to Twisting and Wrenching, 323. Resilience of a Cylindrical Axle, p. 357; PART V Principles of Dynamics, Chapter IV Motions of Pliable Bodies, 608. Nature of the Subject, Vibration, p. 552 (*Rankine, 1858-64). London: Charles Griffin and Company, Limited, Exeter Street, Strand, 1895. Last access May 14, 2019 from:
https://archive.org/download/cu31924031285384/cu31924031285384.pdf.

[42a]Ewart Sigmund Andrews, *The theory and design of structures; Chapter I Strain, stress and elasticity; Resilience, pp. 27-28*. London: Chapman&Hall, Ltd, 17 Henrietta Street, W.C., 1908. Last access May 14, 2019 from:
https://archive.org/details/theoryanddesign00andrgoog/page/n11.

[42b]Ewart Sigmund Andrews, *Further problems in the theory and design of structures; Chapter V Internal work: deflection of framed structures, p. 88; Chapter VI Stresses in redundant frames, The principle of least work, p. 118*. London: Chapman&Hall, Ltd, 1913. Last access May 14, 2019 from:
https://archive.org/details/furtherproblemsi00andrrich/page/n6.
[43]Charles Frederick T. Young 1819-1864, English engineer and writer, *The fouling and corrosion of iron ships: their causes and means of prevention, with the mode of application to the existing iron-clads*, *Appendix, p. 164*. London: The London Drawing Association, 7, Duke Street, Adelphi, W.C., 1867. Last access May 14, 2019 from:
https://archive.org/details/foulingandcorro00youngoog/page/n7.
[44]William John Gordon, *Foundry, Forge and Factory: With a Chapter on the Centenary of the Rotary Press*, *p. 191*. The Religious Tract Society, 56 Paternoster Row, 65 St. Paul's Churchyard and 164 Piccadilly, 1890. Last access May 14, 2019 from:
https://archive.org/details/foundryforgeand01gordgoog/page/n8.
[45]Andrew Wynter (1819-1876, English physician, doctor specialized in insanity, essayist, frequent contributor to periodicals), *Subtle Brains and Lissom Fingers, Being some of the chisel-marks of our industrial and scientific progress*, *Silvertown, p. 33*. London: Robert Hardwicke, 192 Piccadilly, 1869. Last access May 14, 2019 from:
https://archive.org/details/subtlebrainsandl030339mbp/page/n6.
[46]Robert Bentley Todd (1809-1860; Irish-born physician, licensed at the Royal College of Surgeons in Ireland, moved to London, where he practiced medicine and lectured), *The Cyclopaedia of Anatomy and Physiology (*Todd, 1836-59, Ed.)*; Vol. I, A-DEA; Cellular Tissue, p. 510; Cilia, p. 637; Cranium, p. 742*. London: Sherwood, Gilbert, and Piper, Paternoster-row, 1836. Last access May 14, 2019 from:
https://www.biodiversitylibrary.org/item/17031#page/9/mode/1up.
Vol. II, DIA-INS; Diaphragm, p. 5. London: Sherwood, Gilbert, and Piper, Paternoster-row, 1839. Last access May 14, 2019 from:
https://www.biodiversitylibrary.org/item/64529#page/7/mode/1up.
Vol. III, INS-PLA; Muscular System, p. 542; Nervous Centers, p. 669; Physiology of the Nervous System, p. 721; Osseus System, p. 839. London: Sherwood, Gilbert, and Piper, Paternoster-row, 1847. Last access May 14, 2019 from:
https://www.biodiversitylibrary.org/item/15636#page/9/mode/1up.
Vol. IV, part I; PLE-STA; Respiration, p. 337. London: Sherwood, Gilbert, and Piper, Paternoster-row, 1847-49. Last access May 14, 2019 from:
https://www.biodiversitylibrary.org/item/15628#page/11/mode/1up.
Vol. IV, part II; STA-WRI; Touch, p. 1165. London: Sherwood, Gilbert, and Piper, Paternoster-row, 1849-52. Last access May 14, 2019 from:
https://www.biodiversitylibrary.org/item/15639#page/9/mode/1up.
Vol. V, Supplementary Volume; Pelvis, p. 146-147, 183; Organ of Respiration, p. 258; Respiration, p. 287, 290-291. London: Sherwood, Gilbert, and Piper, Paternoster-row, 1859. Last access May 14, 2019 from:
https://www.biodiversitylibrary.org/item/15645#page/9/mode/1up.
[47]David James Hamilton (1849-1909; Scottish pathologist, contributed to the Chambers's book), *A text-book of pathology systematic & practical; Vol. I; The Heart, p. 630; The Blood Vessels, p. 708.* London and New York: Macmillan and Co., 1889. Last access May 14, 2019 from:
https://archive.org/details/textbookofpathol01hamiuoft/page/n8.

Vol. II; Part I; The Liver, p. 210. London and New York: Macmillan and Co., 1894. Last access May 14, 2019 from:
https://archive.org/details/atextbookpathol04hamigoog/page/n9.
Vol. II; Part II; Venous Engorgement, p. 785. London and New York: Macmillan and Co., 1894. Last access May 14, 2019 from:
https://archive.org/details/atextbookpathol03hamigoog/page/n5
[48]Thomas Clifford Allbutt (1836-1925; English physician, inventor of the clinical thermometer), *A System of Medicine by Many Writers (VII Vol).* (Allbutt, 1901, Ed.).London: MacMillan & Co., Ltd., 1901.
Vol. I. Last access May 14, 2019 from:
https://archive.org/details/systemofmedicine01allb/page/n6.
Vol. II. Last access May 14, 2019 from:
https://archive.org/details/systemofmedicine02allb/page/n6.
Vol. III. Dilatation of the Stomach, p. 488, 494, 503. Last access May 14, 2019 from:
https://archive.org/details/systemofmedicine03allb/page/n6.
Vol. IV; Myxœdema, p. 470. Last access May 14, 2019 from:
https://archive.org/details/systemofmedicine04allb/page/n6.
Vol. V; Pneumonia, p. 102. Diseases of the myocardium, p. 896. Last access May 14, 2019 from:
https://archive.org/details/systemofmedicine05allb/page/n6.
Vol. VI; Aneurysm of the Aorta, p. 349. Last access May 14, 2019 from:
https://archive.org/details/systemofmedicin06allb/page/n6.
Vol. VII. Last access May 14, 2019 from:
https://archive.org/details/systemofmedicine07allb/page/n6.
Vol. VIII. Last access May 14, 2019 from:
https://archive.org/details/systemofmedicine08allb/page/n6.
[49]Robert Bell (1800-1867; Irish man of letters), *Eminent literary and scientific men. English poets,* in *The Cabinet Cyclopaedia, conducted by the Rev. Dionysius Lardner, assisted by Eminent Literary and Scientific Men (2 Vol)*, (Bell, 1839). London: Longman, Orme, Brown, Green & Longmans, Paternoster-row; and John Taylor, Upper Gower Street, 1839. The *Cabinet Cyclopaedia* was edited by Dionysius Lardner (1793-1859; Irish scientific writer who popularized science and technology).
Vol. I. Last access May 14, 2019 from:
https://archive.org/details/eminentliterary00bellgoog/page/n6.
Vol. II; Edward Young, p. 344. Last access May 14, 2019 from:
https://archive.org/details/eminentliterary01bellgoog/page/n6.
[50]Robert Tomes ((1817-1882; U.S. physician, doctor, diplomat, writer, surgeon on a vessel of the Pacific Mail Steamship Company), *The Americans in Japan: an abridgment of the Government narrative of the U.S. expedition to Japan, under Commodore Perry, Chapter XVI, Expedition to Japan*, p. 379 (Tomes, 1857). New York: D. Appleton& Co., 346&348, Broadway. London: 16 Little Britain, 1857.
Last access May 14, 2019 and Figures from:
https://archive.org/details/cu31924008787677/page/n8.
[51a]Charles Robert Darwin, *Beagle Diary*, *earthquake and tsunami of Concepcion: pp. 292-303; 445; eruption of Mount Osorno: p. 265.* Edited by Richard Darwin Keynes, Emeritus Professor of Physiology in the University of Cambridge, and fellow of Churchill College, Cambridge University Press, 1988. During his long scientific journey, Darwin writes the following sentences in his *Beagle Diary*; February 20th, 1835 at Valdivia: "… *I was on shore*

& lying down in the wood to rest myself. It came on suddenly & lasted two minutes (but appeared much longer). The rocking was most sensible; the undulation appeared both to me & my servant to travel from due East. There was no difficulty in standing upright; but the motion made me giddy … An earthquake like this at once destroys the oldest associations; the world, the very emblem of all that is solid, moves beneath our feet like a crust over a fluid; one second of time conveys to the mind a strange idea of insecurity, which hours of reflection would never create ..."; March 3rd, 1835 at Conception: "… *As soon as the ship entered the harbor of Concepcion, I landed on the island of Quiriquina, & there spent the day, whilst the ship was beating up to the anchorage. The Major domo of the estate rode down to tell us the terrible news of the great Earthquake of the 20th: - That not a house in Concepcion or Talcuhano (the port) was standing, that seventy villages were destroyed, & that a great wave had almost washed away the ruins of Talcuhano - ... The Island itself showed the effects of the Earthquake, as plainly as the beach did that of the consequent great wave. Many great cracks which had a North & South direction traversed the ground; some of these near the cliffs on the coast were a yard wide; & many enormous masses in every part had fallen down; in the winter when the rain comes, the water will cause greater slips. The effect on the underlying hard slate was still more curious; the surface being shattered into small fragments. If this effect is not confined, as I suppose it is, to the upper parts, it appears wonderful that any solid rock can remain in Chili. For the future when I see a geological section traversed by any number of fissures, I shall well understand the reason. I believe this earthquake has done more in degrading or lessening the size of the island, than 100 years of ordinary wear & tear … Many compared the ruins to those of Ephesus or the drawings of Palmyra & other Eastern towns; certainly there is the same impossibility of imagining their former appearance & condition ... The earthquake alone is sufficient to destroy the prosperity of a country; ... what a horrible destruction there would be of human life. England would become bankrupt; ... To my mind since leaving England we have scarcely beheld any one other sight so deeply interesting. The Earthquake & Volcano are parts of one of the greatest phenomena to which this world is subject…*". Among the final considerations, he says that earthquakes and volcanos "*...possess for me a higher interest, from their intimate connection with the geological structure of the world. The earthquake must however be to everyone a most impressive event; the solid earth, considered from our earliest childhood as the very type of solidity, has oscillated like a thin crust beneath our feet; and in seeing the most beautiful and laboured works of man in a moment overthrown, we feel the insignificance of his boasted power ...*".
Last access May 14, 2019 and Figures from:
https://archive.org/details/darwin-online_2001_KeynesBeagleDiary_F1925.
[51b]Charles Robert Darwin, *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life*, New York: D. Appleton and Company, 443 & 445 Broadway, 1861, A New Edition, revised and augmented by the author;
Chapter III. Mutual checks to increase. pp. 70-71.
Chapter IV. Natural selection p. 80; p. 100-101; pp. 101-102; p. 108.
Chapter X. Geological succession, p. 276; p. 277; pp.281-282.
Chapter XIII. Classification, pp. 372-373; p. 376.
Chapter XIV. Recapitulation, pp. 408-409; pp. 412-413; pp. 415-416.
Chapter XIV. Conclusion, p. 425. Last access May 14, 2019;
http://darwin-online.org.uk/converted/pdf/1861_OriginNY_F382.pdf.

[52]Crawford Stanley 'Buzz' Holling (born December 6, 1930 in the United States to Canadian parents) is a Canadian ecologist, and Emeritus Eminent Scholar and Professor in Ecological Sciences at the University of Florida. Last access May 14, 2019 and Figures from:
https://en.wikipedia.org/wiki/C._S._Holling.
Resilience Alliance. Last access May 14, 2019:
https://www.resalliance.org/.
[53]Eugene Pleasants Odum (1913-2002), was a U.S. biologist known for his pioneering work on ecosystem ecology.
[54]CARRI. Last access May 14, 2019:
http://www.resilientus.org/.
[55]HAZUS-MH. Last access May 14, 2019:
https://www.fema.gov/hazus.
[56]Wikipedia, Supply chain. Last access May 14, 2019:
https://en.wikipedia.org/wiki/Supply_chain.
[57]Talcott Parsons (1902-1979) was an U.S. sociologist, best known for his social action theory and structural functionalism. His theory the intellectual bases of several disciplines of modern sociology. His work is concerned with a general theoretical system for the analysis of society rather than with narrower empirical studies. He is credited with having introduced the work of Max Weber Émile Durkheim, and Vilfredo Pareto to American sociology. Towards the end of his career (1975), he stated that 'functional' and 'structural functionalist' were inappropriate ways to describe the character of his theory. From the 1970s, a new generation of sociologists criticized Parsons' theories as socially conservative.

References

Adger, W.N., 2000, "Social and ecological resilience: Are they related?", *Progress in Human Geography*, 24 (3): 347-364.

Adger, W.N., Hughes T. P., Folke, C., Carpenter, S.R., Rockström, J., 2005, "Social-Ecological Resilience to Coastal Disasters", *Science*, 309 (5737): 1036-1039.

Allbutt, T.C. (ed.), 1901, *A System of Medicine by Many Writers (VIII Vol)*. London: MacMillan & Co., Ltd., 1901.

Alexander D.E., 2012, "Resilience against earthquakes: some practical suggestions for planners and managers", *Journal of Seismology and Earthquake Engineering*, 13, 109–115.

Alexander D.E., 2013, "Resilience and disaster risk reduction: an etymological journey", *Nat. Hazards Earth Syst. Sci.*, 13, 2707-2716.

Alexander, D.E., Davis, I., 2012, "Disaster risk reduction: An alternative viewpoint" (Editorial), *International Journal of Disaster Risk Reduction*, 2: 1-5.

Alighieri, D., 1957, *La divina commedia*, a cura di Natalino Sapegno, R. Ricciardi (Ed.), Napoli, 1957.

Alwang, J., Siegel, P.B., Jorgensen, S.L., 2001, "Vulnerability: A View from Different Disciplines", *Social Protection Discussion Paper n° 0115*, Washington, D.C.: The World Bank, 42 p.

Andrews, E.S., 1908, *The theory and design of structures*, London: Chapman&Hall, Ltd., 17 Henrietta Street, W.C., 1908.

Andrews, E.S., 1913, *Further problems in the theory and design of structures,* London: Chapman&Hall, Ltd., 1913.

Atkinson, P. A., Martin, C. R. and Rankin, J., 2009, Resilience revisited, *Journal of Psychiatric and Mental Health Nursing***,** 16, 137-145.

Baecker, D., 2001. "Why systems?", *Theory, Culture & Society*, 18: 59-74.

Barberis, F., Malavisi, M., Cimellaro, G.P., Mahin, S., 2015, "Fragility curves of restoration processes for resilience analysis", *Proceedings of the 12th International Conference on Applications of Statistics and Probability in Civil Engineering (ICASP12)*, University of Columbia, Vancouver, Canada, July 12-15, 2015.

Batabyal, A.A., 1998, "The concept of resilience: retrospect and prospect", *Environment and Development Economics*, 3 (2): 235-239.

Bell, R., 1839. *Eminent literary and scientific men. English poets,* in *The Cabinet Cyclopaedia, conducted by the Rev. Dionysius Lardner, assisted by Eminent Literary and Scientific Men (2 Vol).* London: Longman, Orme, Brown, Green & Longmans, Paternoster-row; and John Taylor, Upper Gower Street, 1839.

Berkes, F., Colding, J., Folke, C. (Eds.), 2002, *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*, Cambridge, Cambridge University Press.

Beste, L.F., Hoffman, R.M., 1950, "A Quantitative Study of Resilience", *Textile Research Journal* 20 (7), 441-453.

Biondini, F., Camnasio, E., Titi, A., 2015, "Seismic resilience of concrete structures under corrosion", *Earthquake Engineering & Structural Dynamics*, 44 (2015) 2445–2466.

Birkmann, J., Cardona, O.D., Carrenõ, M.L., Barbat, A.H., Pelling, M., Schneiderbauer, S., Kienberger, S., Keiler, M., Alexander, D., Zeil, P., Welle, T., 2013, "Framing vulnerability, risk and societal responses: the MOVE framework", *Natural Hazards*, 67:193-211.

Bloch, D.A., Silber, E., Perry, S.E., 1956, "Some factors in the emotional reaction of children to disasters", *The American Journal of Psychiatry*, 113 (5): 416-422.

Blount, T., 1656, *Glossographia or a dictionary, interpreting all such hard words*, The Newcomb, London, 1656.

Bohun, R., 1671, *A Discourse concerning the origine and properties of wind. With an Historical Account of Hurricanes, and other Tempestuous winds*, Oxford, Printed by W. Hall for Tho. Bowman, 1671.

Brand, F.S., Jax, K., 2007, “Focusing the meaning(s) of resilience: resilience as a descriptive concept and a boundary abject”, *Ecology and Society*, 12 (1): 23.

Brock, W.A., Mäler, K.-G., Perrings, C., 2002, “Resilience and sustainability: the economic analysis of nonlinear dynamic systems”, in: Gunderson L.H. and Holling C.S. (Eds). *Panarchy: understanding transformations in human and natural systems*, Island Press, Washington, D.C., USA, 261-289.

Bruneau, M., Chang, S.E., Eguchi, R.T., Lee, G.C., O’Rourke, T.D., Reinhorn, A.M., Shinozuka, M., Tierney, K., Wallace, W.A., von Winterfeldt, D., 2003, “A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities”, *Earthquake Spectra*, 19 (4): 733-752.

Burton, I., Kates, R.W., White, G.F., 1978, *The environment as hazard*, Oxford University Press, New York, USA.

Cagnan, Z., Davidson, R.A., Guikema, S.D., 2006, “Post-earthquake restoration planning for Los Angeles electric power”, *Earthquake Spectra*, 22 (3): 589-608.

Campbell, T., 1778, *A Philosophical Survey of the South of Ireland, in a series of letters to John Watkinson, M.D.*, Dublin: Printed for W. Whitestone, W. Sleater, D. Chamberlaine, J. Potts, T. Wilkinson ... [and 13 others], 1778.

Cardona, O.D., 2003, “The Need for Rethinking the Concepts of Vulnerability and Risk from Holistic Perspective: A Necessary review and Criticism for Effective Risk Management”, in Bankoff, G. and Frerks, D.H. (Eds.), *Mapping Vulnerability: Disasters, Development and People*, Earthscan Publishers, Londres.

Carpenter, S.R., Walker, B., Anderies, J.M., Abel N., 2001, “From metaphor to measurement: resilience of what to what?”, *Ecosystems*, 4:765-781.

Cerè, G., Rezgui, Y., Zhao, W., 2017, “Critical review of existing built environment resilience frameworks: directions for future research”, *International Journal of Disaster Risk Reduction*, 25: 173-189.

Chambers, E., 1728. *Cyclopaedia, or, an Universal Dictionary of Arts and Sciences*, London, Printed for James and John Knapton et al., 1728.

Chandler, D., Coaffee, J. (Eds.), 2017, *The Routledge Handbook of International Resilience*, Routledge, New York, 2017.

Chang, S.E., Shinozuka, M., 2004, “Measuring improvements in the disaster resilience of communities”, *Earthquake Spectra*, 20 (3): 739-755.

Chauvin, S., 1692, *Lexicon Rationale Sive Thesaurus Philosophicus Ordine Alphabetico digestus*, Rotterodami, apud Petrum vander Slaart Bibliopolam, 1692.

Cimellaro, G.P., Fumo, C., Reinhorn, A., Bruneau, M., 2008, Seismic resilience of health care facilities, *Proceedings of the 14th World Conference on Earthquake Engineering*, Beijing, China.

Cimellaro, G.P., Fumo, C., Reinhorn, A.M., Bruneau, M., 2009, “Quantification of Disaster Resilience of Health Care Facilities”, *Technical Report MCEER-09-0009*, pp. 212.

Cimellaro, G.P., Reinhorn A.M., Bruneau, M., 2010a, “Framework for analytical quantification of disaster resilience”, *Engineering Structures*, 32 (11): 3639-3649.

Cimellaro, G.P., Reinhorn, A.M., Bruneau, M., 2010b, “Seismic resilience of a hospital system”, *Structure and Infrastructure Engineering*, 6: 127-144.

Cimellaro, G.P., Piqué, M., 2016, “Resilience of a hospital emergency department under seismic event”, *International Journal of Advanced Structural Engineering*, 19: 825-836.

Cimellaro, G.P., Renschler, C., Reinhorn, A.M., Arendt, L., 2016, “PEOPLES: A Framework for Evaluating Resilience”, *Journal of Structural Engineering*, 142 (10): 1-13.

Collier, J., Cumming, G., 2011, “A dynamical approach to ecosystem identity”, *Philosophy of Ecology* 11: 201-218, in Gabbay, D.M., Thagard, P., Woods, J. (Eds.), *Handbook of The Philosophy of Science: Philosophy of Ecology*, San Diego: North Holland, 2011.

Colten, C.E., Kates, R.W., Laska, S.B., 2008, “Community resilience: lessons from New Orleans and hurricane Katrina”, *CARRI (Community & Regional Resilience Initiative) Research Report 3*, Washington DC, http://www.resilientus.org/.

Colten, C.E., Sauer, C.O., 2010, “Building community resilience: a summary of case studies from Charleston, Gulfport, and Memphis”, *CARRI (Community & Regional Resilience Initiative) Research Report 9*, Washington DC, http://www.resilientus.org/.

Comfort, L.K., 1999, *Shared risk: Complex systems in seismic response*, New York: Pergamon.

Comfort, L.K., Boin, A., Demchak, C., 2010, *Designing Resilience. Preparing for Extreme Events*, Pittsburgh, University of Pittsburgh Press.

CSRG Climate and Society Research Group, 1979, “The effect of climate fluctuations on human populations”, *Progress Report n. 2,* Clark University, Worchester, Massachusetts, USA.

Cumming, G.S., Barnes, G., Perz, S., Schmink, M., Sieving, K.E., Southworth, J., Binford, M., Holt, R.D., Stickler C., Van Holt, T., 2005, “An exploratory framework for the empirical measurement of resilience”, *Ecosystems*, 8:975-987.

Cusher, B. E., 2015, “Leaders in Conversation: the dialectic model of leadership education in Plutarch’s Lives”, *Journal of Leadership Education* 14(2).

Cutter, S.L., Barnes, L., Berry, M., Burton, C., Evans, E., Tata, E., Webb, J., 2008, “Community and regional resilience: perspectives from hazards, disasters, and emergency management”, *CARRI (Community & Regional Resilience Initiative) Research Report 1*, Washington DC, http://www.resilientus.org/.

Darwin, R.C., 1988, *Beagle Diary,* Edited by Richard Darwin Keynes, Emeritus Professor of Physiology in the University of Cambridge, and fellow of Churchill College, Cambridge University Press, 1988.

Darwin, R.C., 1859, *On the origin of species by means of natural selection or the preservation of favoured races in the struggle for life*, [reprinted 1964]. Cambridge (MA): Harvard University.

Dauphiné, A., 2004, *Risques et catastrophes. Observer, spatialiser, comprendre, gérer*, Paris, Armand Colin (Coll. U - Géographie).

Davidson, D.J., 2010, “The applicability of the concept of resilience to social systems: Some sources of optimism and nagging doubts”, *Society and Natural Resources*, 23 (12): 1135-1149.

Depietri, Y, Welle, T., Renaud, F.G., 2013, “Social vulnerability assessment of the Cologne urban area (Germany) to heat waves: links to ecosystem services”, *International Journal of Disaster Risk Reduction*, 6: 98-117.

Diderot, D., & Le Rond d’Alambert, J.B., 1751-65, *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des mètiers, par une societé de gens de lettres*, A Paris, chez Briasson, David, Le Breton, Durand, 1751-65.

Dovers, S.R., Handmer, J.W., 1992, “Uncertainty, sustainability and change”, *Global Environmental Change*, 2 (4): 262-276.

Field, C., Look, R., Lindsay, T., 2016, *Resilience insight, 12 Cities assessment*, Burohappold Engineering, February 2016.

Fiksel, J., 2003, “Designing resilient, sustainable systems”, *Environmental Science & Technology*, 37 (23): 5330-5339.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C.S., Walker, B., Bengtsson, J., Berkes, F., Colding, J., Danell, K., Falkenmark, M., Gordon, L., Kasperson, R., Kautsky, N., Kinzig, A., Levin, S., Mäler, K.-G., Moberg, F., Ohlsson, L., Olsson, P., Ostrom, E., Reid, W., Rockström, J., Savenije, H., Svedin, U., 2002, "Resilience and sustainable development: building adaptive capacity in a world of transformations", *Scientific Background Paper on Resilience for the process of The World Summit on Sustainable Development on behalf of The Environmental Advisory Council to the Swedish Government*.

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., Holling, C.S., 2004, "Regime shifts, resilience, and biodiversity in ecosystem management", *Annual Review of Ecology, Evolution and Systematics*, 35:557-581.

Folke, C., 2006, "Resilience: the emergence of a perspective for social-ecological system analyses", *Global Environmental Change*, 16 (3):253-267.

Folke, C., Carpenter, S.R., Walker, B., Scheffer, M., Chapin, T., Rockström, J., 2010, "Resilience thinking: integrating resilience, adaptability and transformability", *Ecology and Society*, 15, 20.

Gallopin, G.C., 2006, Linkages between vulnerability, resilience and adaptive capacity, *Global Environmental Change*, 16 (3): 293-303.

Gama Dessavre, D., Ramirez-Marquez, J.E., Barker, K., 2016, "Multidimensional approach to complex system resilience analysis", *Reliability Engineering & System Safety*, 149: 34-43.

Garmezy, N., 1971, "Vulnerability research and the issue of primary prevention", *American Journal of Orthopsychiatry*, 41, 101-116.

Garmezy, N., 1973, "Competence and adaptation in adult schizophrenic patients and children at risk". In: Cancro, R., Dean, S.R., (Eds.), *Research in the Schizophrenic Disorders,* Schizophrenia: The First Ten Dean Award Lectures, Springer, Dordrecht, pp. 163-204.

Garmezy, N., Masten, A.S., Tellegen, A., 1984, "The study of stress and competence in children: a building block for developmental psychopathology", *Child Development*, 55 (1): 97-111.

Godschalk, D.R., 2003, "Urban hazard Mitigation: Creating Resilient Cities", *Natural Hazards Review*, 4 (3): 136-143.

Gordon, W.J., 1890, *Foundry, Forge and Factory, with a chapter on the Centenary of the Rotary Press*, The Religious Tract Society, 56 Paternoster Row, 65 St. Paul's Churchyard and 164 Piccadilly, 1890.

Gordon, J.E., 1978, *Structures*, Penguin Books, Harmondsworth, UK.

Guarino, N., 1998, "Formal Ontology in Information Systems", *Proc. FOIS'98*, IOS Press, Amsterdam.

Gunderson, L.H., Holling, C.S., Pritchard, L., Peterson, G.D., 1997, "Resilience in ecosystems, institutions and societies", *Discussion paper 95*, Beijer International Institute of Ecological Economics, Stockholm.

Gunderson, L.H., Holling, C.S. (Eds), 2002, *Panarchy: understanding transformations in human and natural systems*, Island Press, Washington, D.C., USA.

Gunderson, L.H., 2009, "Comparing ecological and human community resilience", *CARRI (Community & Regional Resilience Initiative) Research Report 5*, Washington DC, http://www.resilientus.org/.

Gunderson, L.H., Allen, C.R., Holling, C. S., 2009, *Foundations of Ecological Resilience, Island Press, 2009.*

Haigh, R., 2015, *Resilient Buildings and Infrastructure*, licensed under the Creative Commons Attribution-Non-Commercial-Share Alike License, Centre for Disaster Resilience, University of Salford, Working in collaboration with ORBEE.

Hamilton, D. J., 1889-94, *A text-book of pathology systematic & practical (2Vol)*, London and New York: Macmillan and Co., 1889-94.

Hammer, J., 1951, *Geoffrey of Monmouth*, *Historia Regum Britanniae, a variant version*. Jacob Hammer (Ed.), Medieval Academy Books, No. 57 (1951).

Handmer, J.W., Dovers, S.R., 1996, "A Typology of Resilience: Rethinking Institutions for Sustainable Development", *Organization & Environment*, 9 (4): 482-511.

Haugen, E.D., Kaynia, A.M., 2008, "Vulnerability of structures impacted by debris flow", in *Landslides and Engineered Slopes*, Taylor & Francis: London, pp. 381-387.

Henry, D., Ramirez-Marquez, J.E., 2012, "Generic metrics and quantitative approaches for system resilience as a function of time", *Reliability Engineering & System Safety*, 99: 114-122.

Herskovits, M. J., 1952, "Some Problems of Land Tenure in Contemporary Africa", *Land Economics*, 28 (1): 37-45.

Hoffman, R.M., 1948, "A Generalized Concept of Resilience", *Textile Research Journal* 18(3): 141-148.

Holling, C.S., 1973, "Resilience and stability of ecological systems", *Review of Ecology and Systematics*, 4 (1): 1-23.

Holling, C.S., 1996, "Engineering resilience versus ecological resilience". In: Schulze P. (Ed.), *Engineering within ecological constraints*, National Academy, Washington, D.C., USA, pp. 31-44.

Holling, C.S., 2001, "Understanding the complexity of economic, ecological, and social systems", *Ecosystems*, 4:390-405.

IFRC, International Federation of Red Cross and Red Crescent Societies, 2004, *World Disasters Report 2004, Focus on community resilience*, http://www.ifrc.org/Global/Publications/disasters/WDR/58000-WDR2004-LR.pdf.

Jerneck, A., Olsson, L., 2008, "Adaptation and the poor: Development, resilience, transition", *Climate Policy*, 8 (2): 170-182.

Kagan, J., 1975, "Resilience in cognitive development", *Ethos* 3 (2): 231-247.

Karamouz, M., Zahmatkesh, Z., 2017, "Quantifying resilience and uncertainty in coastal flooding events: framework for assessing urban vulnerability", *Journal of Water Resources Planning and Management*, 143: 4016071.

Kaynia, A.M., Papathoma-Köhle, M., Neuhäuser, B., Ratzinger, K., Wenzel, H., Medina-Cetina, Z., 2008, "Probabilistic assessment of vulnerability to landslide: application to the village of Lichtenstein", Baden-Württemberg, Germany, *Engineering Geology*, 101: 33-48.

Keill, J., 1708, *An Account of Animal Secretion, The Quantity of Blood In the Humane Body, Muscular Motion*. London: Printed for George Strahan, 1708.

Klein, R.J., Nicholls, R.J., Thomalla, F., 2003, "Resilience to Natural Hazards: How Useful is the Concept?", *Environmental Hazards*, 5 (1-2): 35-45.

Kircher, C.A., Whitman, R.V., Holmes, W.T., 2006, "HAZUS earthquake loss estimation methods", *Natural Hazards Review*, 7: 45-59.

Lasker, G.W., 1969, "Human Biological Adaptability. The ecological approach in physical anthropology", *Science New Series* 166 (3912): 1480-1486.

Lee, R.V., 2010, Darwin's Earthquake, *Revista médica de Chile*, 2010; 138: 897-901.

Leopardi, G., 1832, *Zibaldone di pensieri*, *Pensieri di varia filosofia e di bella letteratura*, Le Monnier, Firenze, 1921, pp. 2228-2231 and 2401.

Levin, S.A., Barrett, S., Aniyar, S., Baumol, W., Bliss, C., Bolin, B., Dasgupta, P., Ehrlich, P., Folke, C., Gren, I.-M., Holling, C.S., Jansson, A.-M., Jansson, B.-O., Mäler, K.-G., Martin, D., Perrings, C., Sheshinsky, E., 1998, "Resilience in Natural and Socio-economic Systems", *Environment and Development Economics*, 3 (2): 222-235.

Levine, S., 2014, "Assessing resilience: why quantification misses the point", *HPG Working Paper*, Humanitarian Policy Group Overseas Development Institute, London, United Kingdom.

Liotta, G., Rossi, L., Gaffiot, F., 2010, *Dizionario della lingua latina, Latino-Italiano,* Hachette Livre, Il Capitello, Torino, 2010.

Luhmann, N., 1982, "The world society as a social system", *International Journal of General Systems*, 8 (3): 131-138.

Mac Arthur, R.H., 1955, "Fluctuations of animal populations and a measure of community stability", *Ecology* 36 (3): 533-536.

Manyena, S.B., 2006, "The concept of resilience revisited", *Disasters*, 30 (4): 433-450.

Masten, A.S., Best, K.M., Garmezy, N., 1990, "Resilience and development: contributions from the study of children who overcome adversity", *Development and Psychopathology* 2 (4): 425-444.

Masten, A.S., Burt, K.B., Roisman, G.I., Obradovic, J., Long. D.J., Tellegen, A., 2004, "Resources and resilience in the transition to adulthood: Continuity and change", *Development and Psychopathology* 16 (4): 1071-1094.

Mavrouli, O., Fotopoulou, S., Pitilakis, K., Zuccaro, G., Corominas, J., Santo, A., Cacace, F., De Gregorio, D., Di Crescenzo, G., Foerster, E., Ulrich, T., 2014, "Vulnerability assessment for reinforced concrete buildings exposed to landslides", *Bulletin of Engineering Geology and the Environment*, 73: 265-289.

May, R.M., 1973, *Stability and complexity in model ecosystems*, Princeton (NJ): Princeton University.

McEntire, D., Fuller, C., Johnson, W., Weber, R., 2002, "A comparison of disaster paradigms: The search for a holistic policy guide", *Public Administration Review*, 62: 267-281.

McManus, S., Seville, E., Vargo, J., Brunsdon, D., 2008, "Facilitated Process for Improving Organizational Resilience", *Natural Hazards Review*, 9 (2): 81-90.

Miles, S., Chang, S., 2006, "Modeling community recovery from earthquakes", *Earthquake Spectra*, 22 (2): 439-458.

Mileti, D., 1999, *Disasters by Design*, Joseph Henry Press, Washington, D.C.

Morris, T., 2004, *The Stoic Art of Living: Inner Resilience and Outer Results*, Open Court Publishing, Carus Publishing Company, Peru, Illinois, USA.

Morrow, B.H., 2008, "Community resilience: a social justice perspective", *CARRI (Community & Regional Resilience Initiative) Research Report 4*, Washington DC, http://www.resilientus.org/.

Moser, S.C., 2008, "Resilience in the face of global environment change", *CARRI (Community & Regional Resilience Initiative) Research Report 2*, Washington DC, http://www.resilientus.org/.

Norris, F.H., 2010, "Behavioral science perspectives on resilience", *CARRI (Community & Regional Resilience Initiative) Research Report 10*, Washington DC, http://www.resilientus.org/.

NRC, National Research Council, 2006, *Committee on Disaster Research in the Social Sciences: Future Challenges and Opportunities. Facing Hazards and Disasters: Under Human Dimensions*, Washington: National Academy Press.

Odum, E.P., 1971, *Fundamentals of ecology*. Philadelphia, W.B. Saunders Company, pp. 574.

Olsson, L., Jerneck, A., Thorén, H., Persson, J., O'Byrne, D., 2015, "Why resilience is unappealing to social science: Theoretical and empirical investigations of the scientific use of resilience", *Sciences Advances*, 1(4), e1400217.

O'Rourke, T.D., 2007, "Critical infrastructure, interdependencies and resilience", *The Bridge-The Journal of the National Academy of Science*, 37 (1): 22-31.

Ott, K., Döring, R., 2004, *Theorie und Praxis starker Nachhaltigkeit*, Metropolis, Marburg, Germany.

Papadopoulos, T., Gunasekaran, A., Dubeyc, R., Altayd, N., Childee, S.J., Wamba, S.F., 2017, "The role of Big Data in explaining disaster resilience in supply chains for sustainability", *Journal of Cleaner Production*, 142: 1108-1118.

Papathoma-Köhle, M., Keiler, M., Totschnig, R., Glade, T., 2012, "Improvement of vulnerability curves using data from extreme events: debris flow event in South Tyrol", *Natural Hazards*, 64 (3): 2083–2105.

Papathoma-Köhle, M., Zischg, A, Fuchs, S., Glade, T., Keiler, M., 2015, "Loss estimation for landslides in mountain areas - An integrated toolbox for vulnerability assessment and damage documentation", *Environmental Modelling & Software*, 63: 156-169.

Pareto, V., 1935, *The Mind and Society*, Harcourt, Brace and Company, New York, 1935.

Parsons, T., 1951, *The Social System*, Routledge, London, 1951.

Parsons, T., 1966, *Societies: Evolutionary and Comparative Perspectives*, Englewood Cliffs New Jersey: Prentice-Hall, pp. 5-29.

Parsons, T., 1970, On building social system theory: A personal history, *Daedalus*, 99: 826-881.

Parsons, T., 1971. *The Systems of Modern Societies*, Englewood Cliffs New Jersey: Prentice-Hall.

Peacock, W.G., Ragsdale, A.K., 1997, “Social systems, ecological networks and disasters: towards a socio-political ecology of disasters”. In: Peacock, W.G., Morrow, B.H., Gladwin, H. (Eds.), *Hurricane Andrew: Ethnicity, Gender and the Sociology of Disasters*, Routledge, London, pp. 20-35 (Chapter 2).

Pelling, M., 2003, *The Vulnerability of Cities: social resilience and natural disaster*, Earthscan, London.

Perrings, C.A., 1998, “Resilience in the Dynamics of Economy-Environment Systems”, *Environmental and Resource Economics*, 11 (3-4): 503–520.

Perrings, C.A., 2006, “Resilience and sustainable development”, *Environment and Development Economics*, 11:417-427.

Perrow, C., 1986, *Complex Organizations: A critical essay*, New York: Random House.

Peterson G., Allen, C.R., Holling, C.S., 1998, “Ecological Resilience, Biodiversity, and Scale”, *Ecosystems*, 1: 6-18.

Phillips, E., 1658, *The New World of English Words, or, a General Dictionary*, London, Printed by E. Tyler for Nath. Brooke, 1658.

Pickett, S.T.A., Cadenasso, M.L., Grove, J.M., 2004, “Resilient cities: meaning, models, and metaphor for integrating the ecological, socio-economic, and planning realms”, *Landscape and Urban Planning*, 69:369-384.

Pimm, S.L., 1984, “The Complexity and Stability of Ecosystems”, *Nature*, 307, 321-326.

Plutarch, 2001, *Plutarch’s Lives* (A.H. Clough, Ed.). New York, NY: The Modern Library.

Provitolo, D., 2012, “The Contribution of Science and Technology to meeting the Challenge of Risk and Disaster Reduction in Developing Countries: From Concrete Examples to the Proposal of a Conceptual Model of Resiliency Vulnerability”. In: Bolay J.-C. et al. (Eds), *Technologies and Innovations for Development*, Springer-Verlag.

Rankine, W.J.M., 1858-64, *A Manual of Applied Mechanics*, 1864 third edition: London, Charles Griffin and Company, Limited, Exeter Street, Strand; first edition in 1858.

Reghezza-Zitt, M., Rufat, S., Djament-Tran, G., Le Blanc, A., Lhomme, S., 2012, “What resilience is not: uses and abuses”, *Cybergeo: European Journal of Geography/Revue Européenne de Géographye*, 621.

Renschler, C.S., Frazier, A.E., Arendt, L.A., Cimellaro, G.P., Reinhorn, A.M., 2010, “A Framework for Defining and Measuring Resilience at the Community Scale: The PEOPLES Resilience Framework”, *Technical Report MCEER-10-0006*.

Robertson, D., 2012, *Build Your Resilience: Teach Yourself How to Survive and Thrive in Any Situation (Teach Yourself: Relationships & Self-Help)*, Paperback, Hodder & Stoughton, London, United Kingdom.

Romieu, E., Welle, T., Schneiderbauer, S., Pelling, M., Vinchon, C., 2010, “Vulnerability assessment within climate change and natural hazard contexts: revealing gaps and synergies through coastal applications”, *Sustainability Science*, 5:159-170.

Rose, A., Liao, S.Y., 2005, “Modeling regional economic resilience to disasters: a computable general equilibrium analysis of water service disruption”, *Journal of Regional Science*, 45 (1): 75:112.

Rose, A., 2009, “Economic resilience to disasters”, *CARRI (Community & Regional Resilience Initiative) Research Report 8*, Washington DC, http://www.resilientus.org/.

Rutter, M., 1985, “Resilience in the face of adversity: protective factors and resistance to psychiatry disorder”, *The British Journal of Psychiatry*, 147, 598-611.

Sheffy, Y., 2007, “Building a resilient organization”, *The Bridge -The Journal of the National Academy of Science*, 37 (1): 30-36.

Sherman, N., 2005, *Stoic Warriors: The Ancient Philosophy Behind the Military Mind*, Oxford University Press, New York, USA.

Thorén, H., 2014, “Resilience as a unifying concept”, *International Studies in the Philosophy of Science*, 28 (3): 303-324.

Thorén, H., Olsson, L., 2017, “Is resilience a normative concept?”, *Resilience International Policies, Practices and Discourses*, 6 (2): 112-128.

Tierney, K., Bruneau, M., 2007, “Conceptualizing and measuring resilience: A key to disaster loss reduction”, *TR News 250*, 14-17.

Tierney, K., 2009, “Disaster response: research findings and their implications for resilience measures”, *CARRI (Community & Regional Resilience Initiative) Research Report 6*, Washington DC, http://www.resilientus.org/.

Timmerman, P., 1981, *Vulnerability, Resilience and the Collapse of Society, Environmental Monograph No.1*, Institute for Environmental Studies, University of Toronto, Canada, April 1981.

Tobin, G.A., Montz, B.E., 1997, *Natural Hazards: Explanation and Integration*, Guilford Press, New York.

Tobin, G.A., 1999, Sustainability and community resilience: the holy grail of hazards planning? *Global Environmental Change Part B: Environmental Hazards*, 1 (1): 13-25.

Todd, R.B. (Ed), 1836-59, *The Cyclopaedia of Anatomy and Physiology (5 Vol)*, London: Sherwood, Gilbert, and Piper, Paternoster-Row, 1836-59.

Tomes, R., 1857, *The Americans in Japan: an abridgment of the Government narrative of the U.S. expedition to Japan, under Commodore Perry*, New York: D. Appleton & Co., 346 & 348, Broadway. London: 16 Little Britain, 1857.

Tredgold, T., 1824, *Practical essay on the strength of cast iron, and other materials, intended for the assistance of engineers, iron masters, architects, millwrights, founders, and other engaged in the construction of machines, buildings, &c.*, London, Printed for J. Taylor, at the Architectural Library, 59, High Holborn, 1824.

Tredgold, T., 1853, *Elementary Principles of Carpentry, a treatise on the pressure and equilibrium of timber framing, the resistance of timber, and the construction of floors, centres, bridges, roofs; uniting iron and stone with timber, etc.*, London: John Weale, 59, High Holborn, 1853.

UNDRR, United Nations Office for Disaster Risk Reduction, 2015. *Sendai Framework for Disaster Risk Reduction*; 2015.

UNISDR, United Nations, International Strategy for Disaster Reduction, 2005, *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters,* World Conference on Disaster Reduction, 18-22 January 2005, Kobe, Hyogo, Japan; Geneva: United Nations International Strategy for Disaster Reduction; 2005.

UNISDR, United Nations Office for Disaster Risk Reduction, 2009. *UNISDR Terminology on Disaster Risk Reduction*, published by the United Nations International Strategy for Disaster Reduction, UNISDR, Geneva, Switzerland, 2009.

UNISDR, United Nations Office for Disaster Risk Reduction, 2012. *Towards a post-2015 framework for disaster risk reduction*, Geneva: United Nations International Strategy for Disaster Reduction; 2012.

Uzielli, M., Catani, F., Tofani, V., Casagli, N., 2015, “Risk analysis for the Ancona landslide-II: estimation of risk to buildings”, *Landslides*, 12: 83-100.

Vale, J.V., Campanella, T.J. (Eds.), 2005, *The Resilient City. How modern cities recover from disaster*, New York, Oxford University Press.

Valery, A.C.P., 1839, *Historical, literary, and artistical travels in Italy: a complete and methodical guide for travellers and artists*, Clifton, C.E. (Ed.), Published by: Baudry's European Library, Paris, 1839.

Von Bertalanffy, L., 1950, "An Outline of General System Theory", *The British Journal for the Philosophy of Science*, I (2): 134-165.

Walker, B., Carpenter, S., Anderies, J., Abel, N., Cumming, G., Janssen, M., Lebel, L., Norberg, J., Peterson, G.D, Pritchard, R., 2002, "Resilience management in social-ecological systems: a working hypothesis for a participatory approach", *Ecology and Society*, 6 (1):14.

Walker, B., Salt, D., 2006, *Resilience thinking: Sustaining ecosystems and people in a changing world*, Washington DC: Island Press.

Walker, B., Gunderson, L., Kinzig, A., Folke, C., Carpenter, S., Schultz, L., 2006, "A handful of heuristics and some propositions for understanding resilience in social-ecological systems", *Ecology and Society*, 11 (1):13.

Wamba, S.F., Akter, S., Edwards, A., Chopin, G., Gnanzou, D., 2015, "How 'big data' can make big impact: findings from a systematic review and a longitudinal case study", *International Journal of Production Economics*, 165: 234-246.

Waugh, W.L., 1996, "Disaster management for the new millennium". In: Sylves, R.T., Waugh, W.L. (Eds.), *Disaster Management in the U.S. and Canada: The Politics, Policymaking, Administration and Analysis of Emergency Management*, Charles C. Thomas Publishers, Springfield, Illinois, pp. 344-359 (Chapter XVI).

Welsh, M., 2014, "Resilience and responsibility: governing uncertainty in a complex world", *The Geographical Journal*, 180 (1): 15-26.

Wilbanks, T.J., 2009, "How geographic scale matters in seeking community resilience", *CARRI (Community & Regional Resilience Initiative) Research Report 7*, Washington DC, http://www.resilientus.org/.

WMO World Meteorological Organization, 1980, *Proceedings of the World Climate Conference*, February 12-23, 1979, Geneva, Switzerland.

Wong, D. B., 2006, "The meaning of detachment in Daoism, Buddhism, and Stoicism", *Dao: A Journal of Comparative Philosophy*, 5 (2):207-219.

Wynter, A., 1869, *Subtel Brains And Lissom Fingers, Being some of the chisel-marks of our industrial and scientific progress*, London: Robert Hardwicke, 192 Piccadilly, 1869.

Young, C.F.T., 1867, *The fouling and corrosion of iron ships: their causes and means of prevention, with the mode of application to the existing iron-clads,* London: The London Drawing Association, 7, Duke Street, Adelphi, W.C., 1867.

Zhou, H., Wang, J., Wan, J., Jia, H., 2010, “Resilience to natural hazards: a geographic perspective”, *Natural Hazards*, 53: 21-41.

Zobel, C.W., Khansa, L., 2013, “Characterizing multi-event disaster resilience”, *Computers & Operations Research*, 42: 83-94.

Zwick, M., 2014, “Complexity Theory & Political Change: Talcott Parsons Occupies Wall Street”. In: Youngman, P.A., and Hadzikadic, M. (Eds.), *Complexity and the Human Experience, Modeling Complexity in the Human and Social Sciences*, CRC Press, 2014, pp. 141-160.

10. Earthquakes and Society: the 2016 central Italy reverse seismic sequence

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Abstract

2016 August 24: an intense earthquake hits central Italy. The area is more extended than ever in the recent Italian history, involving four Italian Regions: Lazio, Abruzzo, Marche and Umbria. The seismic sequence is intense and prolonged, continuing also in 2017. The present work aims at representing a cognitive and interpretative contribution to the surface evidences produced during the seismic crisis of central Italy, particularly referring to the numerous effects on the environment, both primary (superficial faulting) and secondary, related to shaking. Moreover, the vastness of the involved area suggests the need of approaching the reconstruction by following new criteria, set on the integration of technical-scientific knowledge, socio-economic requirements and - above all – prevention.

Keywords: 2016 Earthquakes, Central Italy, Prevention, Seismic sequence, Society

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1. Introduction

In 2016 August 24, an earthquake hit central Italy. The area has an unprecedented extension in the recent Italian history, involving four Italian Regions: Lazio, Abruzzo, Marche and Umbria. The seismic sequence was intense: the Magnitude moment of the first event was 6.0, and the epicenter was in Accumoli (Rieti province, Lazio region). A further event (Magnitude 5,4) whose epicenter was in the territory of Norcia (PG Perugia province, Umbria region), followed the first. The earthquake swarm was intense, and further earthquakes hit the province of Macerata (Marche region): on 26 October in Castelsantangelo sul Nera (Mw 5.4) and Ussita, (Mw 5.9). The strongest event (Mw 6.5) occurred in in Norcia (PG). The hypocenters' depths, as identified by the INGV are registered between 7.5 and 9.2 kilometers, thus inducing severe damages. The sequence continued also in 2017: in particular four events took place on January 18 with epicenters in Montereale (Mw 5.1), Capitignano (Mw 5.5) Pizzoli (5.4) and Cagnano Amiterno (5.0) in the province of L'Aquila (Abruzzo region).

All the earthquakes, as well as directly damaging the building, cultural and infrastructural heritage, have effects on the environment. These can be classified as primary and secondary, respectively consisting of permanent deformations of the topographic surface (superficial faulting, subsidence or raising of portions of territory) or essentially linked to shaking (seismic-induced landslides, the liquefaction of granular soils, fractures). Earthquakes generally also induce hydrological variations in the source regime and can generate anomalous waves (tsunamis) both at sea and in smaller basins. Following the highest magnitude events in Central Italy in 2016, in particular those of 24 August, 26 and 30 October, there were numerous effects on the environment, both primary and secondary. The present work reports the results of the implementation of a database, created specifically for the enormous amount of data acquired, and the GIS associated with it.

2. Analysing the 2016 central Italy reverse seismic sequence

As told before, the effect of earthquakes on structures and landscape can basically be divided into two types: direct and secondary effects. Particularly, the direct effects are related to the deformation of the ground at the fault whose breakage has generated the seismic event and the effects are limited to an area that is short and close to breakage. The secondary effects resulting from the temporary passage of seismic waves may, however, also affect very large areas, causing a widespread presence of permanent effects on the Earth's surface which may affect very large areas, which, in relation to the length of the fault and the magnitude released by the event can be in the order of thousands of km².

Following the seismic events commenced on 24 August 2016 (M6.0) and continued with the shocks of October 26 (M5.4 and M5.9) until October 30 (M6.5), the Unicam GeomorphoLAB Group has mapped and computerized about 4000 permanent deformations on the Earth's surface recognized in an area of over 6000 km²: fractures to the ground, activation and reactivation of large landslides and DSGSD (deep seated gravitational slope deformation) dolines, mud volcanoes and liquefaction phenomena, landslides and small dams, changes in the water regime of the springs and the flow of rivers, cracks and / or fractures and / or deformations on network infrastructures, etc. (Fig. 1, 2).

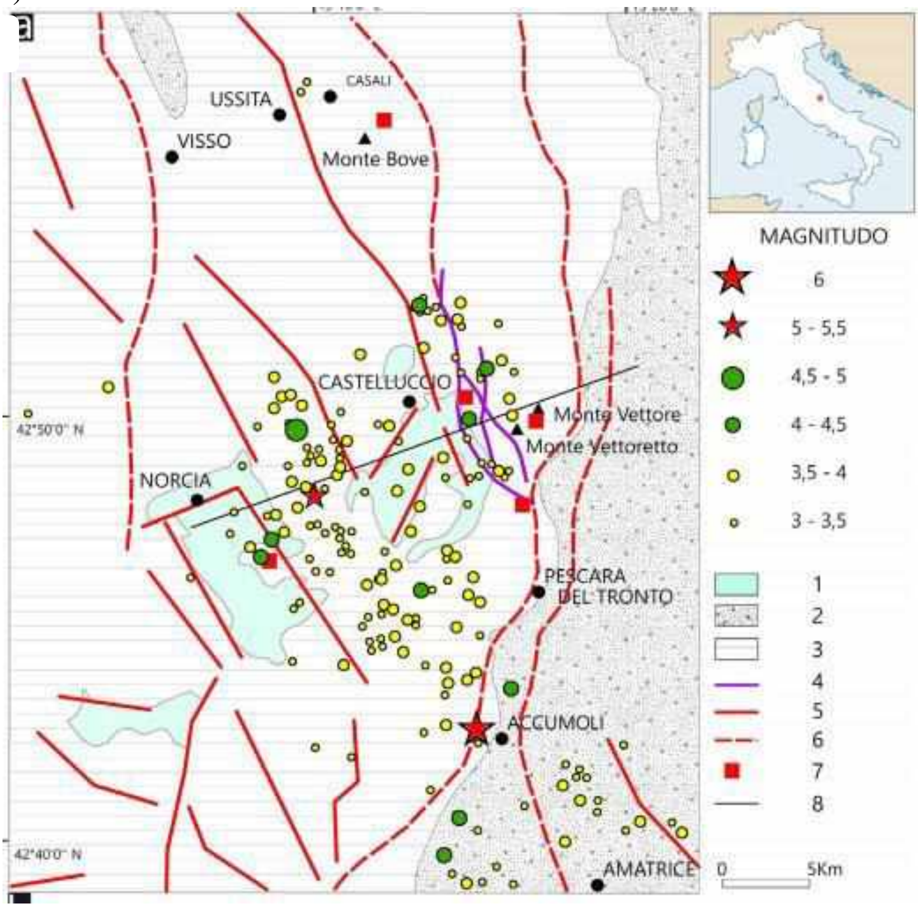

Figure 1 - *Geological and structural sketch of the study area with location of the main epicenters (updated September 25th 2016 – source INGV): 1) Quaternary continental deposits; 2) mainly arenaceous-pelitic bed- rock; Mesozoic-Cenozoic 3) mainly calcareous and marly calcareous bedrock; Miocene 4) Monte Vettore fault system; 5) main dip-slip and transverse faults; 6) main thrusts; 7) main DSGSD's and large landslides* (Aringoli et al 2016).

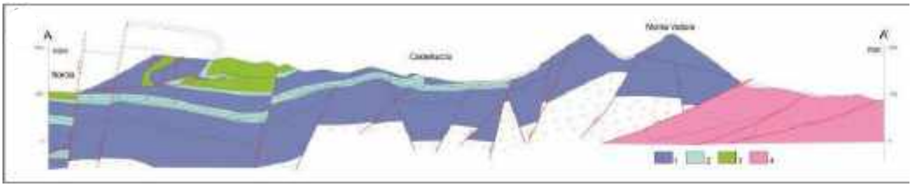

Figure 2 - *Schematic cross section (see Fig. 1).: 1) mainly calcareous formations; 2) marly calcareous formations; 3) calcareous and marly calcareous formations; 4) arenaceous-pelitic formations (Aringoli et al., 2016).*

Since August 24th 2016, the central region of Italy, in particular Marche, Abruzzo, Lazio and Umbria regions, has been experiencing an important seismic sequence, involving an area of about 5000 km2 The first earthquake of magnitude 6.0, with epicenter located near the town of Accumoli (Rieti, Lazio), was followed by about 57,000 aftershocks and four other major seismic events of, respectively, 5.7 M, 5.9M, 6.5M and 5.7M (respectively on October 26th, October 30th 2016 at about 19:10 and at about 21:30 on January 18, 2017).

Following the main event, checks were immediately carried out on the environmental effects of the earthquake, in particular those related to the reactivation of the fault system, hypothesized as the "earthquake faults", as well as on the secondary effects related to the main aftershock (e.g. landslides, fractures to soil, variations in the hydrogeological characteristics of the sources, sinkholes, etc.) in order to map and catalog all the evidence. Some of these studies have already been the subject of recent publications or scientific reports (Farabollini et al., 2016; Aringoli et al., 2016; Farabollini et al., 2017; Civico et al., 2018).

3. Geological and seismic characteristics of the area

The Castelluccio basin is an intra-mountain depression, located in the central Apennines and filled with fluvial-lacustrine sediments deposited during the middle Pleistocene up to the Holocene (Coltorti & Farabollini, 2002); the basal units are instead represented by micritic and pelagic limestones of Jurassic-Miocene age (Pierantoni et al., 2013 Fig. 1).

The main geomorphological modeling of the landscape began during the late Pliocene, when humid or subtropical climatic conditions, favorable to planning processes, created a low-energy paleo-landscape.

The following tectonic phase, active from the lower-middle Pleistocene up to now (AAVV, 2018), is characterized by dip-slip and oblique faults and by strong uplifts. The focal mechanisms refer generally to a distensive type, in agreement with the extensional tectonic regime to which is subjected the part of the Apennine chain where the earthquakes are located (AAVV, 2018).

These processes have interrupted and disarticulated the previous landscape, forming a series of tectonic depressions, such as Colfiorito, Castelluccio, Norcia, Cascia, Leonessa, etc., which characterize the entire Apennine area (Coltorti & Farabollini, 2002 cum bib.; Aringoli et al., 2016). The produced quaternary uplift, together with the stratigraphic arrangement, generated an intense morphodynamic activity that led to the significant remodeling of the previous landscape, also activating large landslides and DSGSD (deep seated gravitational slope deformation) (Aringoli et al., 2010); some of which showed evidence of reactivation during the current seismic sequence.

As for seismicity, two main historical and instrumental destructive earthquakes have been documented on January 14, 1703 (X MCS, Mw = 6.6) and September 19, 1979 (Ms = 5.9, focal depth of 6-8 km) although many others occurred over time, especially in the eighteenth century (Rovida et al., 2016), but with much smaller magnitudes, given the low degree of damage reported. Error data and focal earthquake mechanisms show a pre-existing NE-SW extension, but also certain strike-slip and reversal mechanisms (Cello et al., 1997). These historical earthquakes, including the recent one, have been associated with the activity of an active fault system operating in the NNW-SSE direction from Colfiorito to L'Aquila and interpreted as the superficial expression of deep seismogenic faults (Tondi & Cello, 2003).

The slope of Monte Vettore is characterized by the presence of two normal faults (Farabollini & GeomorphoLab, 2018): the lowest fault is present at the base of the Scarpata del Vettore and limits the Castelluccio basin. The upper fault instead, passes very close to the summit of Mount Redentore, and is marked by a clearly visible escarpment over a length of about 7 km, commonly called "Cordone del Vettore" and also reported in the 1957 IGM cartography. In fact the western slope of Mount Vettore is the morphological expression of this SW-NNW-SSE (total length 30 km) tectonic immersion element, with northern termination at Mount Bove (Pierantoni et al., 2013).

4. Coseismic geological effects

Immediately after the events of August 24th and, subsequently, after those of October and January, the Geomorpholab Group of the University of Camerino, along with fellow geologists from Marche Region and from other Research Bodies (DPCN, INGV and ISPRA), moved across the territory in order to photograph, map, classify, catalog and computerize, via GIS platform, the innumerable evidences of surfaces related to the seismic shaking in the crater area. The direct effects are related to the deformation of the soil at the fault whose breaking has generated the seismic event. The effects are limited to an area that is not very extensive and close to breaking (Civico et al., 2018).

The secondary effects, resulting from the temporary passage of seismic waves, have also been identified very far from the epicenters, causing a widespread presence of permanent evidence on the earth's surface that, in relation to the length of the fault and the magnitude released by the event, have been estimated at thousands of km2 (AAVV 2018). More than 4000 evidences have been collected, which allowed to build a database on the effects of the earthquake, distinguished in direct effects and secondary effects (Farabollini et al., 2017): ground fractures, activation and reactivation of large landslides and DGPV, collapses of sinkholes; mud volcanoes and liquefaction phenomena, landslide dams, changes in the water regime of sources and the flow of rivers, fissure and / or fractures and / or deformations on road and on various infrastructures, and on infrastructure network, etc.

The observations on the geomorphological effects caused by the earthquake show a close correlation and casuistry with those that occurred during previous seismic events that affected the central Apennines, such as the Umbria-Marche seismic sequence (1997) or that of L'Aquila (2009), although the latter showed very minor and widespread evidence in a considerably smaller area (Farabollini & GeomorphoLab, 2018)

The main evidences found in the so called crater area (a recent Italian way to define the area hit by the earthquake) are reported below, in the attempt to describe, when possible and based on their morphogenetic and morphodynamic importance, the peculiar characteristics that distinguish them and allow them to be classified as coseismic effects.

1 - Reactivation of large landslides and deep slope gravitational deformations. In a previous study, Farabollini et al. (1995) have shown that about 500 large landslides and / or DGPVs have been identified in the Apennine, of which 200 fall within the area of the so-called crater of the seismic sequence of August 24th and later. The analysis conducted on the latter showed that about 25% of them underwent reactivation, both in terms of a general phenomenon and in terms of individual morphological elements.

In the area of Passo Cattivo, at the top of the Tenna valley, typical elements of deep slope gravitational deformations have been identified, which also had superficial sensations, always linked to gravity. In particular, on the crest of the Cima Vallinfante slope

- Monte Porche, a series of arched trenches are recognizable, parallel to each other and gradually of smaller size and extension proceeding towards the valley floor of the Tenna river, the most important of which cuts the top of the ridge itself, both on satellite images of August 4, 2013 and May 18, 2016, and which appear not to have been reactivated following the seismic event of August 24, 2016, but which instead have a width of about 2 meters and a depth estimated at about 1.5 m, after the seismic events of October 2016 (Fig. 3).

Figure 3 - *Arched trenches on the Monte Porche.*

After the seismic events of October, extensive landslides were reactivated, above all, rock collapses and avalanches, present in the mid-summit portion of the Vallinfante slope, creating vast detritus cones at the base of the slope itself and producing a clear retreat of the main slope, with tension fractures aligned according to the arched shape of the landslide scarp itself, with detachments, rocky pinnacles and protruding blocks; furthermore, these materials could also be re-mobilized as a result of the cryoclastic action given both by the strong fracturing that pervades the rock mass and by the calcareous nature of the rock mass itself and its slightly friable hilly characteristics.

The morphological elements mentioned above allow us to assume the presence of a deep gravitational deformation (DSGSD) which affects the highest part of the slope with a depth of some hundreds of meters and partially covered by debris deriving from collapse landslides and debris-flow like processes - that continuously occur throughout the area (Farabollini & Spurio, 2008). The genesis of this phenomenon, which can be defined as a deep rock creep, can be associated with the high energy of relief generated by the quaternary tectonic uplift, by the important and pervasive interaction between the Monte Vettore fault system and the Sibillini Mountains overthrusting (Aringoli et al., 2016) and by the strong fracturing of the rock mass.

2 - Rock collapses and / or debris avalanches: They are mainly present along slopes in places that are not very steep, affecting anthropized and non-populated areas (Montegallo, Monte Vettore, Valnerina, Sasso Spaccato). In some cases these phenomena have also caused barriers in the rivers' flow, with the creation of shallow and temporary lake basins (Valnerina; Gola dell'Infernaccio);

3 - avalanches: on the south-east slope of Mount Sibilla - Monte Porche and Monte Bove connected with the snowfall type of December and especially on 6 January and later on 16-19 January 2017, followed by major seismic shocks (18 January 2017); to this end, the evidences of avalanche activity probability due to seismic activity of the shocks at 10.33 local time in Montemonaco and Bolognola- Pintura, were reported on models 1 of the State Forestry Corps - Meteomont Service -.

4 - activation and / or reactivation of persistent superficial landslides on road and network infrastructures of the "crater" area (Fig. 4) of even considerable dimensions;

Figure 4 - *Landslides on the road, triggered by the EQ.*

5 – Structural failure and / or collapse, formed on the Pian Grande of Castelluccio for the reactivation of one of the numerous sinkholes present in the plain, with a sinking of about 4 meters and for a width of about 5 meters;

6 - liquefaction phenomena and mud volcanoes identified respectively near the industrial area in Caldarola and in the Curetta di S. Vittoria region in Matenano;

7 - fracturing and / or ground cracks (Fig. 5) which have widely affected the entire epicenter area: for the former, certainly the most extensive, it is worth mentioning those present along the ridges extending from Mount Porche - Cima Vallelunga - Mount Argentella, to Monte Sibilla or Monte Fema, for an estimated length of over 3 km; for the latter, on the other hand, the assessment of the deformation effects makes it possible to estimate the amount of infrastructures (roads) involved in these effects at nearly 1200 km.

Figure 5 - *Fracturing and ground cracks.*

8 - Soil deformations mainly related to sedimentation and / or compaction of the Quaternary sediments to which the high degree of damage to infrastructures and inhabited centers (Pescara del Tronto, Piedilama, Pretare, Amatrice, etc.) and the numerous deformations of road and / or network infrastructures must be attributed.

The situation of the Pescara del Tronto hamlet is worth to be mentioned: the geomorphological analysis, both in the countryside and in aerial photography, and the detailed analysis of both the pre-quaternary substrate and the Quaternary sediments filling the Tronto valley and of their geometrical and stratigraphic characteristics, allowed to highlight a much more complex picture compared to what was expected on the basis of simple surface observation or deriving from analysis of the local seismic response of soils.

The total collapse of the built-up area of Pescara del Tronto, compared to the strong damage verified in Capodacqua village, located a few km from the first, is due to the high heterogeneity of the quaternary deposits, given by the considerable thickness of continental sediments, differently organized and cemented, and its strong lateral and vertical variations of facies, shifting from stratified debris deposits to chaotic deposits of extensive landslide bodies, up to travertine deposits of “cascade” facies, interdigitated to deposits in "cascade and tub" facies.

The wide area of distribution of the coseismic effects and their widespread variability and frequency, made it possible to understand how the causes of the high heterogeneity of the effects on the physical environment and of the strong diversity, with the same structural characteristics of the buildings, of the damage is attributable to a very articulated geomorphological context, also given by buried morphologies that sometimes fall only outside the field analysis and can be solved through acquisition of data deriving from specific geostatical surveys (AAVV, 2018).

Finally, as regards the presence of fractures with an arcuate curve, circular depressions and circoid morphologies, in areas of low or no significant energy, which has also conditioned, in places, the anthropization of the territory, both in the infrastructures and in the agricultural activities, it has been related to the presence of dolines and / or sinkholes, both on quaternary deposits (Pian Grande di Castelluccio) and on calcareous substrate (Monte Bove- Monte Porche-Monte Sibilla).

These morphologies, linked to karstic processes that have affected the calcareous substratum of the area affected by the earthquake, are very often masked by quaternary filling deposits, and can only be recognized by careful geomorphological analysis from aerial and countryside photos. In all likelihood, the different presence and heterogeneity of behavior, both of ground fracturing and damage, can find a wide explanation precisely in the presence of such manifestations, as amply demonstrated by the evidences related to the 2009 L'Aquila seismic crisis (Farabollini et al., 2012).

9 – Changes in the range of some sources. During the seismic sequence, important variations in the water regime of the sources present in the crater area were highlighted. In fact, important flow rates have been reported for almost all the "deep" sources in the epicentral area (source of Pescara del Tronto, Capodacqua and Foce di Montemonaco) fed by the aquifers of the

Piani di Castelluccio and Monte Vettore areas. The range increases even by several tens of liters / second, as in the case of the San Chiodo source of Castelsantangelo sul Nera (in the hours following the earthquake) and / or temporary alterations of the chemistry with sporadic increases in water turbidity. In some cases, even the "disappearance" of the source itself occurred, as in the case of the Forca Canapine source in the Ascoli area, which disappeared after the earthquakes of 26 and 30 October 2016 (which contributed with a flow rate of over 50 l / s to the 'water supply of the municipalities of Fermano and Piceno) (Aringoli et al., in press).

Perhaps the most striking example is that of the source of Torbidone, in the municipality of Norcia which disappeared after the earthquake of 1979 and was reactivated after 30 October 2016 with a flow that gradually increased until reaching, at the beginning of February, about 2000 l / s.

5. Coseismic database

The Marche Region is among the few regions to have total coverage of extremely detailed geological information, largely deriving from the effort made to contribute to the Geological Map of Italy at the scale of 1: 50,000 — CARG Project (CARG, 2019; Servizio Geologico d'Italia, 1995) and, thanks to a memorandum of understanding with the Emilia-Romagna Region, the Umbria Region and the Tuscany Region, the Marche Region is now planning the realization of a territorial continuum at the 1: 10,000 scale resulting from a complex homogenization work. These data are therefore being integrated into a specific relational database for geological mapping covering the entire territory of the four Regions; from this database, specific theme can be extracted as needed, to support planning, design, analysis and research.

Thanks to some dedicated projects (CARG, 2019) most of the surface of the Marche Region is also covered by geomorphological data that are equally detailed and are also organized in a local database. With this in mind, a project to gather new information following the recent seismic crisis had necessarily to be designed taking into account the needs of computerization, georeferencing and interrogation in relation to existing data (Angelini, 2014); at the same time the vastness of the topic of the coseismic database and the multiplicity of possible inputs and signals suggested an agile interface, with the possibility of a continuous evolution and updating and with opportunities for extremely simplified visualizations and queries. The first phase of the creation of a database consists in the identification of the entities and of the knowledge domain to be described and in defining its relationships (Servizio Geologico d'Italia, 1995). The new data collected were therefore organized in an easily editable local entity / relationship type database that, through the overall evaluations over the next few months, could suggest specific research topics, indicate criticalities and suggest updates in the existing cartography (Fig. 6).

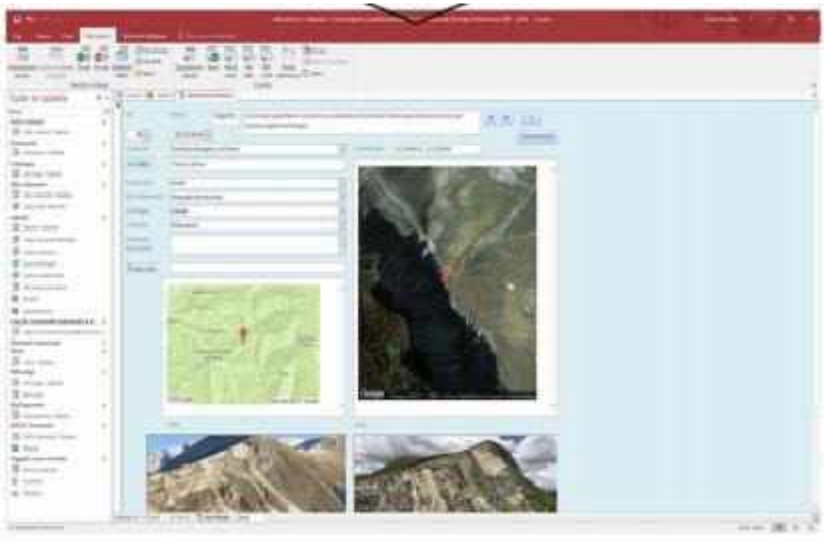

Figure 6 - *Display of the local database.*

The data have been inserted as punctual features, equipped with a progressive and univocal identifier (ID) within the territorial domain, thanks to the WGS'84 decimal coordinates; this domain is made up of the areas affected by the 2016-2017 seismic sequence. Each recorded information maintains the essential characteristics of the phenomenon among its attributes and refers to external links for the type of observation and for auxiliary information. The database uses concepts of entities / relationships to correctly manage the geographic (topological) and information (attributes) related to real mapped objects: this is how some information levels are defined, within which geographic features are stored based on "families" of encoded data; the other data may or may not be linked to the analysis in progress depending on the aspect to be highlighted (Angelini et al., 2013) (Bourrogh & McDonnel.1998)The application offers a simple, operational interface, within which there are spaces for signaling transient elements and free notes, as well as a series of menus for unambiguous identification of the emergency. The interface mask translates the codes used to store the information, so as to make it usable even when a local database is not available.

At the inserted point of interest, some specific external tabular information has been linked, about the lithology of the lands involved, the geomorphological scenario in which the form or process reported and, in order to make immediate identification, extracts of Google maps, punctual and / or panoramic images.

The forms compiled according to the architecture described above, can however be used both for the construction of a new platform integrated with geological and non-geological spatial data, and for the continuous updating of the database, and for the monitoring of morphodynamic and morphogenetic aspects.

6. Final observations

The analysis of the numerous evidences found in the area of the so-called "crater" has allowed us to estimate that about 70% of the effects found are attributable to fractures and coseismic cracks; that about 8% are due to landslides S.L. and to deformations, while about 20% to failure of road and network infrastructures and the remaining 2% to failure, variations in the water regime and other minor causes. The GeomorphoLab is working on the realization of more detailed analysis of the data, however, it should be pointed out that the database is certainly not complete as some situations more or less limited and not very evident have not been taken into consideration, including the long seismic sequence that generated earthquakes of more than 5M from August to January 2017, that has often amplified and superimposed effects already produced with the first shock on 24 August, making it sometimes difficult to acquire the data.

In the area affected by the long seismic sequence, the geological survey shows the presence of numerous quaternary faults (AAVV, 2018) all with indications of recent activity. On the basis of their dimensions, it is possible to attribute a seismogenic potential up to 6.5Mw. Along many of these faults there have been superficial phenomena that in some cases have rejuvenated the rock slope and / or faulted soil, with freeface rated up to 1 m (Monte Vettore).

The problem that arises is therefore that of the suitability of the resolution of the geological analysis for the evaluation of the seismic hazard of an area:

in fact, on the basis of considerations on the return times of the strong earthquakes of the central Apennines, Norcia fault could have been reported as the seismogenic fault, rather than thinking of the other faults which, however, have very evident morphological expressions (Vettore fault, Monte Bove fault, Campotosto fault, etc.) (Farabollini & GeomorphoLab, 2018).

Similar to the purely geostructural aspect, it is necessary to take into consideration the geomorphological effect on the environment and on the damage, trying to verify and, above all, quantify the role of some geomorphological elements that characterize the central Apennine territory, and in particular the role played by the large landslides in the quiescent state or the Deep Gravitational slope Deformations, in determining effects of local amplification both in bedrock and in the continental Quaternary deposits. In this way, based on the effects on the soil and on the damage to the buildings, it would also be possible to effectively locate the epicenter areas, especially for those defined by historical data.

In parallel, we'd like to point out that it is essential to address some themes, so far considered as related to different branches of knowledge. The recent seismic events in the center of Italy have once more highlighted two of the most dramatic lacks in the field of territorial management of our country: the infrastructure maintenance and the prevention. The reconstruction is a complex and delicate action too, more difficult due to criticality in the cultural approach. The mainstream culture rarely takes into consideration geology, as if the study of earthquakes and the reconstruction projects should be related just with engineering and architectural issues. The problems related to the geological hazard of the territory, the so-called site effects, the relationship between the substrate, its natural evolution and buildings: all these are not adequately considered. Geology should not be relegated to a subsidiary role in spatial planning: the response of territory (intended as the integration of nature and culture) to natural events derives precisely from its geological structure, its evolution, its transformations as well as from the social consciousness of such concepts.

Referring to the need to reason about the slogan "as it was, where it was," divulged by mass media as a promotion for a reconstruction that respects the historical value of the destroyed sites, it would be desirable to base projects and actions on a multidisciplinary approach. Teams including experts from various fields of expertise, are complete where geologists, geotechnics, geophysicists, hydrogeologists, architects, engineers, and jurists, economists, sociologists, psychologists, should collaborate in a synergic and complementary way.

It is essential to highlight that doing a good job does not mean working slowly: the post-earthquake management must be speeded up to give answers to the inhabitants of the affected areas. Eradicating citizens from their place of residence for a too long time, causes dramatic consequences, such as the abandonment of places and the loss of culture. It would be right to bring the communities back to live in safety in their "places of the heart"; the communities have to be rebuilt even before the houses. For this purpose it is needed to start a dialogue with individual/community/society living the territory and policymakers, aiming at creating synergy and empathy: reconstruction can start and go on, following this way. Moreover, it is mandatory a stronger development in the field of communication, by sharing information, in the aim at starting a social risk consciousness and strengthening risk prevention.

An essential basis to deal with land management, both in terms of risk prevention and in the emergency and post-emergence phases, is the knowledge. The study of geological and geomorphological settings is mandatory to analyze the territorial context, as well as its possible evolution in case of seismic events. Such information should be the foundation of each territorial planning policy, giving the technics -and the whole society- those criteria to be followed in order to ensure adequate, sustainable and safe lives for individuals/communities/society.

References

AAVV, 2018, Le attività del Servizio Geologico d'Italia (Ispra) a seguito della sequenza sismica del 2016-2017 in Italia Centrale. June 2018, *Geologia dell'Ambiente - Italian Magazine of Environmental Geology* XXVI(1/2018):117-135

Angelini S., 2014, Banche dati e geomorfologia: esempi e applicazioni a partire da dati CARG. Atti del Convegno, Dialogo intorno al paesaggio, I, pp. 25-36.

Angelini S., Farabollini P., Menotti R.M., Millesimi F., Petitta M., 2013, "Application of the compurised cartography to the territory management: the geomorphological map of palaeolandslides in the Velino River Valley". *Landslide Science and Practice, Spatial Analysis and modeling*, Springer, III, pp. 415-421.

Aringoli, D., Bufalini, M., Farabollini, P., Giacopetti, M., Materazzi, M., Pambianchi, G. & Scalella, G. (in press), Effetti geomorfologici e variazioni idrogeologiche indotti dai terremoti: esempi nell'area epicentrale della sequenza sismica 2016-2017 del centro Italia. Atti Conv. Sigea, Preci, 2017.

Aringoli, D., Farabollini, P., Giacopetti, M., Materazzi, M., Paggi, S., Pambianchi, G., Pierantoni, P.P., Pistolesi, E., Pitts, A. & Tondi, E., 2016, "The August 24th 2016 Accumoli earthquake: surface faulting and Deep-Seated Gravitational Slope Deformation (DSGSD) in the Monte Vettore area", *Annals of Geophysics*, 59(5), https://doi.org/10.4401/ag-7199.

Aringoli, D., Gentili, B., Materazzi, M. & Pambianchi, G., 2010, "Mass movements in Adriatic Central Italy: Activation and evolutive control factors". In: Werner, E D. and Friedman H.P., Eds., *Landslides: Causes, Types and Effects*, pp. 1-72.

Bourrogh, P.A. & McDonnel, R.A., 1998, *Principles of Geographical Information Systems*. Oxford University press.

CARG Project, 2019, http://www.isprambiente.gov.it/it/progetti/suolo-e-territorio-1/progetto-carg-cartografia-geologica-e-geotematica; accessed on 09.09.2019.

Civico, R., Pucci, S., Villani, F., Pizzimenti, L., De Martini, P.M., Nappi, R. & the Open EMERGEO Working Group, 2018, "Surface ruptures following the 30 October 2016 Mw 6.5 Norcia earthquake, central Italy", *Journal of Maps*, 14(2), 151-160, https://doi.org/10.1080/17445647.2018.1441756.

Coltorti, M. & Farabollini, P., 2002, "Quaternary evolution of the Castelluccio di Norcia Basin (Umbro-Marchean Apennine, Central Italy)". *Il Quaternario*, 8 (1), 149-166.

Farabollini, P., Folchi Vici d'Arcevia, C., Gentili, B., Luzi,, L., Pambianchi G. & Viglione F., 1995, "La morfogenesi gravitativa nelle formazioni litoidi dell'Appennino centrale", *Memorie della Società Geologica Italiana*, 50, 123-136

Farabollini, P. & Spurio, E., 2008, 2Applicazione dei GIS nello studio dei fenomeni di debris flows dell'appennino umbro-marchigiano (Regione Marche, Italia)", *Rendiconti Online della Società Geologica Italiana*, 2, 1-9.

Farabollini, P., Aringoli, D., Materazzi, M., Pambianchi, G., Pierantoni, P., Scalella, G. & Tondi, E., 2012, "Il terremoto aquilano del 6 aprile 2009: rilievi geologici, geologici del Quaternario e geomorfologici e considerazioni per la prevenzione del rischio sismico e per la ricostruzione post-terremoto". *Geologia Tecnica & Ambientale*, 2, 58-74.

Farabollini, P., Aringoli, D., Materazzi, M., Pambianchi, G. & Scalella, G., 2017, Large Landslides and Deep Seated Gravitational Slope Deformation triggered by the 2016-2017 central Italy seismic crisis: first evidences from the Mount Vettore-Mt Bove epicentral area. Abs. Int. Workshop “From 1997 to 2016: Three destructive earthquakes along the central Apennine fault system, Italy”. July 19-22, 2017.

Farabollini, P., Angelini, S., Fazzini, M., Lugeri, F.R., Scalella, G. & GeomorphoLab, 2018, “La sequenza sismica dell'Italia centrale del 24 agosto e successive: contributi alla conoscenza e la banca dati degli effetti di superficie”, *Rendiconti online della Società Geologica Italiana*, 9-15. DOI: https://doi.org/10.3301/ROL.2018.45

Pierantoni, P., G. Deiana, and S. Galdenzi, 2013, “Stratigraphic and structural features of the Sibillini Mountains (Umbria-Marche Apennines, Italy)”. *Ital. J. Geosci.,* 132(3), 497-520.

Servizio Geologico d’Italia, 1995, *Linee guida della Carta geologica d’Italia alla scala 1:50.000*, Quaderno n. 6, Guida all’informatizzazione. Ed. Ist. Poligraf. e zecca dello Stato.

Tondi, E. & Cello, G., 2003, Spatiotemporal Evolution of the Central Apennines Fault System (Italy), *Journal of Geodynamics*, 36, 113-128.

11. The recovery strategy of second homeowners and tourists after a disaster: insights from the 2016 central Italy earthquakes

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Abstract

Between August and October 2016, 131 municipalities in central Italy were severely hit by a series of earthquakes. Although official data on properties in those municipalities is scant, this area is generally acknowledged as a second home tourist destination. The impact that the earthquake has had on this very peculiar and interesting local community is worth to explore because it highlights the particular role that long stay tourists, the home holidays makers, might have in case of a social, physical and economic disorder provoked by a socio-natural disaster. The aim of this chapter is to discuss what needs to be tackled by response and recovery disaster management policies when second homes are involved, by considering also expectations and intentions of the affected owners with regards to tourists needs included in the redevelopment plans. This research uses a mix methodology combining geo-referenced 2016 Copernicus and 2011 Census data to geo-mapping second homes tourism and qualitative in-depth interviews with 20 second home owners and policy makers in Amatrice (one of the worst affected townships) to explore the role that they have been playing in the different phase of the disaster cycle.

Keywords: Disasters, second home, families ties, temporary inhabitant, reconstruction policies

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Introduction

As well known, tourism is not immune by disasters: as already noted, they can be seen as interlinked processes (Mugnano & Carnelli, 2016): the tourist industry and tourist destinations can be affected by every phase of the disaster cycle. Both tourism disaster management should account for disaster risk reduction measures (Faulkner, 2001) and a tourist destination can be either positively or negatively influenced by a disaster, depending on local contexts, vulnerability issues and the disaster phase itself (Mugnano & Carnelli, 2016; Cohen & Cohen, 2012). What usually emerges from the literature, as being quite unexplored, are the needs of the tourist population before, during and after a disaster: this may be a consequence of the tourist population as seen as a separate population from the locals, which are usually the target of disaster risk reduction ad recovery efforts and policies. As we will discuss in this chapter, the interaction between second home tourism and an earthquake can unveil and follow different logics. Second home residents are a very peculiar population. The fact that they have the administrative residence in another place, that they use the second home some period of the year (weekly, seasonally), make them be considered as tourist. On the other side, it cannot be eluded that a large number of the second home residents can be considered (or they consider themselves) "temporary residents". The choice of buying a holiday house is not only an economic investment but is a psychological, social and emotional choice. The literature debate on tourism and disaster strongly argues that tourists are more vulnerable then locals in case of a disaster because «they are less familiar to local hazards and the resources that can be relied on to avoid risk, and they are less independent» (Faulkner, 2001, p. 22). In the same line, the local knowledge is not only a resource of the residents but can be a shared cultural heritage with other populations. Indeed, the second home residents might have developed through years a place attachment, a local social capital and important know how on the territory. Often, in the process of electing the destination for settling the second home, those temporary residents have developed an accurate and specific curiosity on the territory. Some second home residents have a deep knowledge and interest on the local history, on the geological morphology on the local tradition and so on. In addition, in Italy, as well as in most of countries that have experienced a rather recent process of urbanization, the phenomenon of second home is often the effect of an intergenerational transmission of housing assets. Properties often located in rural and not urbanized areas might have belonged to the families for generations. And one's upon a time, before the strong process of urbanization, it might have been the main residence for the family or the relatives. So, tourist second homes might also have had an affective value because represent the roots of their families, and it can take the shape of a specific segment of tourism called root tourism.

The central Italy 2016 earthquakes is certainly and interesting case study to investigate this interesting interconnection between a disaster, second home residents and the root tourism dynamics. Is it true that second home residents are fragile tourists or they can become resourceful actors in the different phase of the disaster cycle? Focusing on Amatrice - one of the places most affected by the earthquakes - this work aims to analyze the role that home holiday makers have played and are playing in reconstructing the social, political and physical domains of the local community. Due to the scare data of the phenomenon of second homes in Italy, and in particular those affected by the natural disaster, the chapter proposes proxy estimation of the phenomenon in the area of Amatrice by cross-referencing data produced by *Copernicus*, the European satellite system for detecting damage caused by disasters, and the census of empty home. This proxy estimation provides the context scenario within which a qualitative fieldwork was conducted in July 2017[4].

1. Second home tourism and disasters: Italy as a case study

It is only in recent years that second tourist houses are emerging as a matter of academic relevance (Hall & Müller, 2004; Roca, 2013; Hall, 2014). Research on second homes has been conducted from a wide variety of disciplinary perspectives and consequently has addressed numerous themes, such as their implications for: household behavior, leisure spaces and consumption (Kaltenborn & Bjerke, 2002); tourism, urban–rural interaction,

[4] The research team -composed by F.Carnelli, M.Migliore, S.Mugnano, S.Zizzari- has conducted 20 interviews with owners of damaged second homes in Amatrice or in the nearby areas; institutions, associations and institutions for tourism promotion. The research has been possible thanks to the *Quota Competitiva* UNIMIB funds. The research is part of a larger project called Emidio di Treviri. A special thank you should be direct to *Brigate di Solidarietà Attiva* (BSA) without whom the fieldwork could not have been possible.

retirement and seasonal migration (Williams and Hall 2000), and for social structures, housing markets and landscapes in districts where second homes are concentrated (Skak, 2004). Among the topics covered so far, the concepts of “home”, “mobility”, “planning” “governance" and “policy” have been analyzed in relation to some dimensions, including environmental, social and, of course, housing (Hall, 2014; 2015). Mobility and place attachment should be central elements of a local governance taking into account second homes: «there is a strong sense of belonging in second-home owners, even when they do not originally come from the area» (Rey-Valette et al., 2014, p. 36). On the contrary, on the one hand some research shows how the behavior (and social vulnerabilities) of tourists and residents in facing a disaster can be different (Mugnano & Carnelli, 2016). On the other hand, the phenomenon of second tourist homes is usually neglected by housing policies, urban planning, real estate market regulations, but also by territorial development plans, especially and paradoxically related to economic activities related to tourism (Roca, 2013).

This absence is even more marked if public policies concern post disaster reconstruction, where no distinctions is made among the different typologies of tourists. The length of time spend or the periodicity of the visits in the same tourist destination definitely have a different impact on the type of tourisms’ engagement with local community. In this prospective the case of second home is surely an interesting perspective of research.

The second house usually refers, even if the literature in not so precise on this topic, to a dwelling that is not a person's main residence, used by tourists in the leisure time and in particular periods of the year and that remain empty for majority of time (Hall, 2014a).

Armondi (2011), among others, using a definition of second home proposed by Pardoe, defines it as:

«a *static property, which is the alternative residence of a family, the main domicile of one who usually lives elsewhere, intended by the members of that family primarily for entertainment and recreation*» (Armondi, 2011, p.149).

Although in Italy (Ferrero, 1998) it is almost impossible to make a precise estimation of the phenomenon, we can argue that a proxy calculation of the phenomenon can be made. Based on the latest census, it can be assumed that in Italy approximately 7.000.000 dwellings are un-occupied either empty or occupied by people who are not permanently residents, among which only 2 million can be classified as second homes. The 2 million are in fact either located in urban context and can be consider a form of investment or located in rural areas or territories with a low density (3 million) The housing market of the second home sector follows differ dynamic compared to other sector of the market. According to the data on second holiday homes between the 2016-2017 the sell and buy transitions have increased of 3.5% even though this trend is not homogenous across the country. Some distinction can be made between the different touristic destinations: the seaside and lake destinations are still quite attractive (+4,8%) while the mountains are drastically decreasing (-4.3%). The average price of a second home properties is approximately 2.000 euro per sqm, even though there are some regions were the price has dropped. It is interesting that the areas that have had the highest property devaluations are those affected by the earthquake: Umbria (-4.5%) and Abruzzo and Lazio (-4.1%). Fortunately, due the specific typology of second homes the area is not yet affected by negative equity effect. The area, in fact, although is strongly featured by second home tourism, this is mainly shaped as root tourism.

In general terms, in Italy the second home phenomenon can be seen in part as the result of specific private touristic development plans and in part as the result of process of urbanization of the population during the fordist time. The latest can be seen as strongly connected to the root tourism which are properties in rural areas inter-generational transmitted or inhered. Often this phenomenon derives from the emigration of people from the most marginal areas to the wealthiest cities and areas, a process that occurred progressively from the Second World War onwards in Italy (Perri, 2013).

The so-called roots tourism, in Italy can be understood as: «the movement of people who spend leisure stays in the place in which they themselves, and/or their families, were born and where they lived before emigrating to places, which, in time, have become the ones where they now live permanently» (Perri, 2013: 56). The area of study can be presumably considered second homes derived by a root tourism, therefore the properties are not recently bought but probability inherited. In this case, the negative equity, which is the potential indebtedness when the property's value falls below the outstanding amount of the mortgage, is relatively limited considered the number of second home in the area.

In more details, the rea of study has an incredible presence of second home. According to an estimation made in Arquata del Tronto out of 1648 dwellings of housing stock market 922 can be considered second home (56% of the all stock). In Accumoli out of 1123 dwellings of housing stock market, 650 can be considered second home (58% of the all stock). Last but not least, in Amatrice out of 5257 dwellings of housing stock 76% can be considered second homes. Within this scenario which is strongly characterised by second home and the peculiarity of the type of tourism, the devaluation value of the property reported seems not to had a massive impact in terms negative equity.

2. The second home as a representation of families ties

Our study area is not new to earthquakes and in particular, in 1639, Amatrice and some surrounding areas were destroyed by a strong earthquake (Tertulliani et al., 2016). In addition, following the 24th August first shock, three other major earthquakes took place on 26th, 30th October 2016 and 18th January 2017, making these earthquakes a seismic swarm. In particular, a total of 131 municipalities were affected, with a great deal of damage, 316 dead and at least 400 injured. The impact of the earthquake was devastating. As Tertulliani et al. (2016) pointed out, real estate in the affected area belongs to traditional construction and in many cases is rural. It is located on a plateau at about 1000 meters above sea level, with an area of 174.4 square kilometers and a low population density and, as reported by ISTAT (2016), just under 2,600 residents in 2016. A peculiar characteristic of Amatrice is its almost 70 hamlets very sparsely populated and scattered over an extensive mountainous territory. Since the '20s it has suffered a slow depopulation, which has provoked a rapid aging of the villages and recent a new Renaissance of the touristic sector. Indeed, the area is composed by 69 villages and since 1991 is part of the National Park of Gran Sasso and Monti della Laga. From a morphological point of view the area is formed by mountainous and rural areas, and no important urban center exists. In terms of economic activities, a very limited part is dedicated to long lasting tradition agriculture and sheep-farming, however the more recent and emerging sector is the tourism one.

The area hit by the earthquake is composed by 131 municipalities which approximately is 1,728 square kilometers, where 25,000 people live (ISTAT, 2017). Amatrice and Accumoli in the province of Rieti and Arquata del Tronto in the province of Ascoli Piceno are the most affected places by the earthquake Pescara del Tronto, a hamlet of Arquata del Tronto, has been razed to the ground. Most of the hit municipalities have a resident population that rarely exceeds 2000 inhabitants: the most populous one is Norcia with 4,957 inhabitants. The population density is also very low. They are very small communities, often isolated hamlets, characterized by an elderly resident population.

In the three municipalities most affected, the percentage of buildings damaged varies from 16% to 20% of the total and almost all of them are residential and most of the damage is concentrated in the historic centers, cross-checking the data of Copernicus for damage caused by the shock of August 24, 2016 with data from the 2011 census (ISTAT, 2011)[5], OpenStreetMap Extracts and GeoFabrik we visualized the impact of the earthquake in our case study in Fig.1.

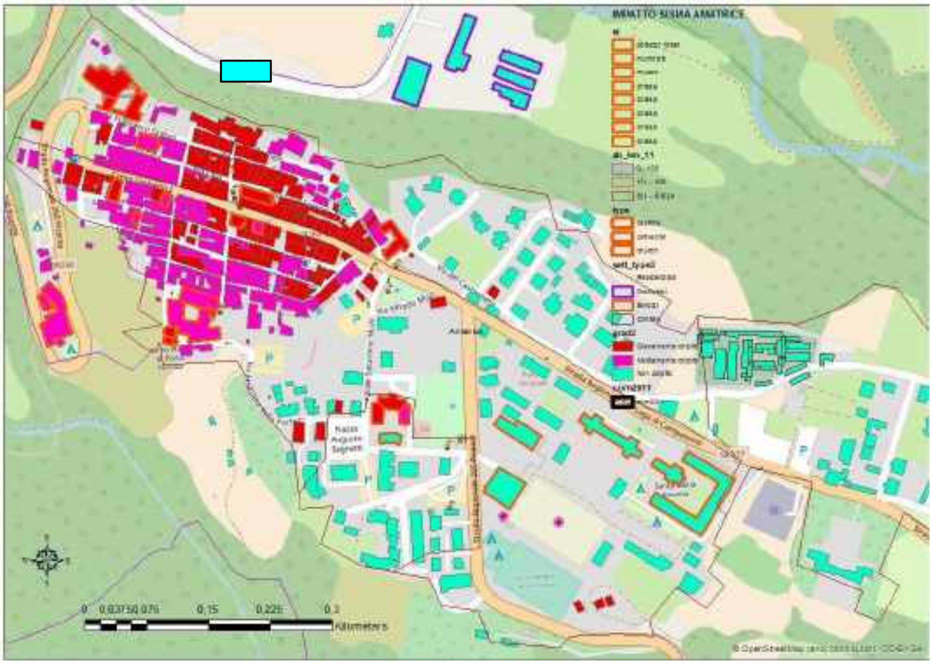

Figure 1 - *The devastation the earthquake: affected buildings in Amatrice. Source: elaboration of Migliore with GIS data.*

In our representation, the severely affected buildings are in red, the medium affected buildings are in fuchsia and non-affected buildings are in blue. As far as their intended use is concerned, residential buildings (i.e. the majority) have no outline; productive buildings have a lilac outline, service buildings are orange. As shown in fig. 1, the historical center of Amatrice has suffered the most serious damages: about 75% of the buildings have been hit.

[5] It's important to highlight that there is a mismatching between the data collected by Copernicus and those of the Census. Copernicus, in fact, gathers information on building unit instead of the Census is based on individual housing units. In this research the unit of investigation is the building. In addition the results reported an estimate of the damage and is based on the data relative to a few hours after the earthquake. In fact, no further earthquakes in October 2016 and January 2017 were considered.

While some hamlets have been destroyed. The entire area is a very famous touristic destination, and tourism is an important part of the local economy. Agriculture and livestock, in fact, offer many "typical" products, also appreciated on an international scale. This has led to the expansion of the gastronomic tourism and "Amatrice" and the "*pasta all' amatriciana*" are one of most famous Italian recipe across the globe. In addition, the area have some naturalistic attractions, such as the thermal springs and the Gran Sasso and Laga Mountains National Park and it is rich of cultural and religious heritage. However, in this area the leading segment of the touristic sector, as it has mentioned before, is the high number of second homes and vacationers who spend the summer and the weekends in the area. According to our estimation, as mentioned above, the highest numbers of second home both in the area is in Amatrice and this data has been also confirm by the mayor of Amatrice who talks of «5,500 [are] second homes, in Amatrice and 69 hamlets». Another aspect that the research reveal is that the typology of second homes is very much connected to the root tourism, e.g.:

«*Santa Giusta, I am not talking of Santa Giusta of Amatrice has always been a small reality. The only commercial activity was my uncle's restaurant, no shops. In the winter the residents were 3, 4, 5, probably in the summer we were 200-300*».

A very common story telling is that in this area the second home is an intergenerational house transmission:

«*yes, my father inherited the house from my grandfather… and it was passed from my grandfather's father. From one generation to another*».

Although, in the collective imaginary, owners of second homes are simply defined as tourists, in their own perspective things are different: on one hand, actual residents have always considered them as an integral part of their community

For the residents:

«*the real tourism, let's say, is the occasional tourism, is mainly linked to the one-day tourism, people who come, eat and go away*» (an NPO member).

While the second home owners are more "locals":

«*I was born in Rome and I was also born here*» (Rome inhabitant/second home in Retrosi, Amatrice).

In other words, in this context second home tourists can define as a sort of odd inhabitant-tourist, a "temporary inhabitant". The relationship between the second home owners and the residents is quite natural, so they are not perceived as strangers to the community. The quite-intermittent presence is not considered as an extraordinary element but ordinary aspect of the community life:

«*the tourism in Amatrice was mainly based on second homes, people who came back from the city to the town, either in the weekends or in every bank holiday in the year*» (bar manager/Hotel in Amatrice).

From the interviews, it comes clearly out that it exists a strong bond between the history of the place, the family history and the house's memories. Some of the interviewees spend free time in the area because their parents, relatives o grandparents come from there; some others were born there and then had moved for work or study reasons to a bigger city; some others because part of the family has a property there. Several interviewees have mentioned that during the fifties and sixties the process of urbanization provoked a massive de-population of the area, and the villages had first turned into a ghost town with only few residents and then slowly to a touristic destination for families who had left. Only very recently a new type of tourism, more related to gastronomic events and short breaks, has started to become common.

Being tourist, in the words of the interviewees, can take different shapes: you can be a tripper, a holidaymaker or you have a second home because your families' roots are there. The relationship between place, individual and motivation strongly depends on what kind of tourism is experienced and what kind of impact you have on territories. The social, economic and urban impact is different, according to the type of tourism. As second home owners clearly argue,

«*Obviously, I consider myself a tourist, but I came here because I am rooted to this area. The tripper exist, but they are a minority, the majority here are holidaymakers with affective ties: families or friends*».

In another interviews this distinction in not related to the property but to the sense of belonging to the place. Beyond the mere housing tenure, it seems clear that Amatrice, as well as other villages in the area, has not been the outcome of a touristic destination development, but the research of the family's roots which has turned the area into a touristic destination. Their history and past are very relevant in the creation of the second life of those villages.

«here the second home tourism does not really exist, like when you buy a house on the beach".

In the majority of cases,

«those properties are like families' memories»

It is undebatable the added value of this specific typology of tourism and the important role played by the local community. Indeed, Long-lasting residents and home holiday makers are nourishing each other and keeping those villages alive. In opposition to other tourist destinations in which there is an open conflict between tourists and residents, in this area the different social groups had developed before the earthquake a mixed social capital which has improved the quality of life of this area and has created an important bond.

«The holidaymakers are the hard core of this area. Imagine that at the begging of last century, the trippers coming here were shocked by the fact that almost all were speaking in roman [instead of the dialect of Amatrice]. In winter the area was guarded by locals, from May to October, during school holidays, the area was guarded by holidaymakers (…)».

Throughout the decades, the tourism in Amatrice has changed alleging to new mode of experiencing leisure time. According to the interviews, in the sixties and seventies, in summer, holidaymakers populated Amatrice for a rather long period. Some interviewees remembered, indeed that as soon as the schools ended, the families, especially mothers with kids, moved to summer holiday houses until September. Social and economic changes, such as women's access to the labor force, changes in the education system and economic constrains, have reduced the "one long holiday" model. Then, Amatrice and its surroundings have increasingly turned into a weekend escape especially for those home holidaymakers living in the nearby urban areas, such as Rome, Chieti, Naples. However, the persisting temporary and constant use of second home, have maintained and in some cases reinforced the relationship between locals and second home owners, who are often not perceived as strangers but part of the local community. On the contrary, the contribution and active participation of second home owners to the social and cultural life of most of those villages is very significant. In specific, during the interviews several examples of this cohesive community have been mentioned, such as the creation of a *PROLOCO* (which is a touristic entity in charge to promote and foster social and cultural activities for the town), or the promotion of projects to develop a better use of public spaces, etc.

In such a cohesive community, it is very interesting to explore how social dynamics have been affected during the different phases of the disaster. In other words, the following sections analyses whether the second home owners, who by the literature are classified as tourists, have behaved during the emergency phase or the recovery phase.

3. Managing the emergency in a touristic destination: strengths and weakness of a root tourist destination

On August 24th, the center of Amatrice and the surrounding districts were hit in various ways by the first shake, the impact was devastating and the majority of buildings collapsed. Immediately, the state of emergency was declared and the institutional engine was activated. Although was summer, the holiday period was almost over and therefore only few of the respondents were in town. However, almost all the interviewees recorded vividly where and what they were doing when they got the news. For them, although they did not directly experience the earthquake, their storytelling represents a traumatic moment:

«it was a miracle, because I had to go to Amatrice but the actor Daniele Pecci phoned me (...) and then I replied "I'll see you tomorrow morning for the scene, I'm not going up to Amatrice anymore. Here, I no longer went to Amatrice for this. Not only when we set up the scene of Hamlet, I entered the scene with a coffin and entered this coffin and pulled out skulls, the skull that is then given to Hamlet ... I don't know if a thing of destiny, a particular thing» (Amatrice's inhabitant).

The sense of belonging of all holidaymakers is so strong that most of them perceived themselves as victims, even though they were far away from Amatrice. Alternatively, according to the literature, one of the aspect to take under control in the rescue phase is the evacuation management strategy. In the case of Amatrice, most of the interviewees told us that the first intention (and action) was to go to their house and friends to help. It was “a call to the roots” and several of them immediately decided to go to Amatrice to help the survives and the local community:

«*We were going there, on the way they called my husband back on duty, because the colleague didn't feel well, so by chance we were not there. But we had almost all the relatives there who were waiting for us and we ran to go*» (Amatrice’s inhabitant).

Another key aspect in the emergency phase is to house the displaced people who have lost everything because of the disaster. In this specific case, the problem was not quantitative but qualitative. The very peculiar social and economic context of the area played a very important role in the organization of the support. Considered the affected area and the degree of devastation, the number of re-settlements were relatively limited. The high percentage of second homes and the relatively low season period became immediately a straight, rather than a weakness. The real problem was to understand who were the people in needs and activate the rescue procedures. The local community, and Amatrice is a clear example, in that precise moment was mostly composed by the residents’ majority of elderly people, and in contrast to the expectations, the rescue procedures need to focus on residents rather than tourists.

In some cases the emergency of was handled by hosting some of the victims in hotels on the Adriatic coast, in other case the solution was to offer financial contribution, in other the CAS[7] were provided, a very limited resources were devoted to the tourists. Thus, even if Amatrice is a very famous touristic destination, in practice the rescue procedure had followed the normal path.

3.1. Time-lapse for the reconstruction phase

The reconstruction phase was designed by controlling the static conditions of the buildings giving priority to those which were less damaged, in order to allow the return back of those who reported a minor damage, and to provide temporary accommodation to displaced people in specific emergency housing solutions (SAE, *Soluzioni Abitative Emergenziali*) i.e: little re-mountable houses, already furnished and earthquake-proof. However, due to a delay in providing this solution, many small hamlets are still today deserted and those few people, who have decided to stay, created self-made housing solutions such as containers, caravans, waiting for the SAE. As a girl states:

*«Now there's nobody left in the town, the houses are still in place, but only two are usable. And are those belonging to whom use to always live here" (*Amatrice's inhabitant*).*

The case of Amatrice, unfortunately is following the tragic path of most of the reconstruction phases in Italy: doubts and perplexities for the future emerged, the perception of lack of information and clarity, and being forgotten by the institutions, as reported by the interviewees.

However, what makes this disaster different from the others is that the government has specifically designed the reconstruction policies by taking into consideration the specific features of the area and a specific attention is given to second-home properties. The reconstruction policy specifically mentions that the financial incentives for the reconstruction are targeted to all buildings located in the "seismic crater" (100% reimburse), namely precisely the possible faction of the property "first houses, productivity activities and holiday houses". In case the damaged properties, no matter if they are main residences or second homes, are located near to the affected area, the contribution is 100% "for principal homes and productivity activities", in case the properties, are situated outside the affected area 50% of the contribution was given for restoring/rebuilding second homes .

The relevance of this reconstruction policy oriented also to second homes highlights the acknowledge that second homes has had on the economic and social development of Amatrice's territory. Several interviews underlined that the local economy was mostly based on the presence of touristic second homes, and local social life was also helped by the tourists. Associations, institutional stakeholders and local groups stressed that local promotions of the cultural life of the area had a high presence of second home owners in the organization.

«More than correct, it is necessary because one can't talk about the reconstruction of a place if does not talk also of reconstruction of the social texture and this tissue was done in this way and they realized it in no time» (coordinator Proloco).

A coral opinion, both by side residents and second home owners, is that the future of this area cannot be possible without the opportunity to attract the tourists back to the area again.

«*The majority of houses are second homes, making a different choice had the same meaning of leaving this town. More than what is my personal interest, but also thinking about the wellness of this town, in my opinion it was the best choice*» (second-home inhabitant in Roma/Sommati).

As it has been also confirmed by Amatrice major, Sergio Pirozzi, who was in charge since then, and endorsed this policy.

«*If there had not been this, we would have closed the doors…if there had not been the 100% (...). It was clear right away that it wasn't a request for an assault to the couch, but it was drawn on the awareness of the economic fabric of the territory*» *(second-home inhabitant in Preta/Roma).*

The open question, however, is not what to re-build and where but when this will happen. The process of reconstruction, as we know, is very slow in Italy. The problem emerges when the time for re-building is different for the two groups: first local inhabitants should be housed by re-building or fixing the properties, and then, the others will follow.

«*(...)we know that those territories are mainly made of second homes. Local current residents of those municipalities are very few, while, in August, residents are multiplied by ten. The majority of the houses in those territories are second homes. Not financing the second homes has the same value of not giving housing capability back to those territories*» (an NPO).

This policy of funding management seems to show a contradiction: although the two categories are considered completely equal in terms of financial contribution, the reconstruction timings are different. A territory needs people and economy to work.

«*(...) we know that those territories are mainly made of second homes. Local actual residents of those municipalities are very few while, in August, residents are multiplied by ten. The majority of the houses in those territories are second homes. Not financing the second homes has the same value of not giving housing capability back to those territories*» (an NPO).

Further, the plan of economic contributions established for reconstruction/fixing the same timing, even if the damage are different and some second homes can be occupied again with a very small investment as Castel Trione homeowners tells:

«*The municipality has a shortsighted and wrong attitude (…) because they preclude the possibility to come back to those who have the home B… They did not make an investigation on every district to see which are collapsed, to be tore down, to be rebuilt, those that are usable, those that, with little intervention, come back usable again. You have to allow a flow of people which comes back and lifts the economy up again*» *(Roma/Castel Trione).*

However, in general, there is the fear that the reconstruction could be delayed for everybody: above all, the elder residents suffer with resignation from the fact that they will never see their own home re-built:

«*I don't believe it, not even for first homes… I think I will die in there. I requested it twice, I was not chosen, so what*» *(coordinator Proloco).*

And a community which is based on an elderly population and temporary residents the time might be a very risk factor for the future of the area. It might be that this area will lose again the change to turn to be alive.

4. Conclusion: short term strategy to keep the area attractive. Will it be enough?

The touristic sector in Amatrice was massively affected by the earthquakes. And the situation got even worsen also due to the 2016/2017 winter weather (abundant snowfalls in January 2017) and the Rigopiano tragedy. According to Bartolini and Pillo (2017), before the earthquake, in the affected area the tourism sector was estimated around 9Bn Eur yearly, with 5.2m arrivals, 20m days of tourism presence, 25k involved companies attracting 600m of expenses from foreign tourists only. The economic impact was devastated: the hit areas registered a drop of 90% in arrivals, while others, not directly involved, had from 30% to 50% drop between November to December 2016. Apart from the disaster, also media had created a negative imagine by sensationalizing the tragedy, and stigmatizing not only the hit area but also the surrounds. In general, in order to make tourists to come back to the affected areas, the government started touristic promotion campaigns with the aim of supporting the local economy and buzzing again the tourism industry.

In the case of Amatrice, the campaign was mostly oriented to food tourism by promoting a food district- *Area del gusto, della tradizione e della solidarietà*- a network of local restaurants. The "*Amate Amatrice*", designed by Stefano Boeri was financed through a fund-raising strategy and tried to create events and activities related to the local food industry of the area. In general, it can be argued that in the short term tourism initiatives might help to re-locate the area into a tourist destination, and re-brand it. In the case of Amatrice, the initiatives linked to food and wine tourism and to the surrounding mountains, will probably have an important impact in the short term, but they won't create a new imagine of the area, yet. However, the open question is now: how this re-branding strategy will be combined with the main drivers of the tourism industry in the second homes area? Timing seems to be the main challenge of the reconstruction phase. What the research has highlighted is that short after the shock second home owners are still very attached to the place and they are willing to come back to the area. However, there are still many unresolved questions.

The short-term strategy promoting social events and performances was oriented to attract the tripper and the short break tourist, but it is not clear if it is connected to the more long-lasting strategy, which is the second-home coming back strategy. At the moment, this seems not completely achieved.

Although the reconstruction policy, for the first time, have acknowledged the role of second home owners in the recovery and reconstruction process, the risk is that the reconstruction will come too late. The interviewees have insisted on their place attachment, but the question is for how long will their ties to Amatrice resist? The risk of losing interest in the area or in re-building houses is very high. Personal decisions and economic constrains - such as the devaluation of properties, for example - might lead to new tourist destinations. While the short policies for the tourists are more related to the soft initiatives - festival, events, food branding etc-, the longer one are related to the structure of the villages - re-building the houses. At the moment, it seems that first there is an unbalance between the short and the long reconstruction strategy, and second that the two strategies are targeting two different typologies of tourism. Although the policy towards second home owners is very innovative, the implementation following the traditional steps might be very ineffective and it might not lead to the construction of the strong and lively local community that existed before the earthquake.

References

Armondi, S., 2011, “Trasformazioni della mobilità residenziale turistica. Dalle ‘seconde case’ alle nuove pratiche di uso e abbandono del territorio”, *Territorio,* 3(58), Franco Angeli, pp. 148-154

Cohen, E., Cohen, S.A., 2012, “Current sociological theories and issues in tourism”, *Ann Tour Res* 39 (4):2177-2202.

Faulkner, B., 2001, “Towards a framework for tourism disaster management”, *Tourism Management*, 22, pp. 135-147.

Ferrero, G., 1998, “Seconde case, politiche urbanistiche e turismo nelle Alpi occidentali italiane”, *Revue de géographie alpine,* 86 (3):61-68.

Hall, C.M. (2014) Second home tourism: an International Review, In *Tourism Review International*, 18: 115-135.

Hall C. M., Müller, D., 2004, *Tourism, mobility and second homes: Between elite landscape and common ground*, Clevedon: Channel View.

ISTAT, 2011, *Censimento generale della popolazione*, Roma.

ISTAT, 2016, *Caratteristiche dei territori colpiti dal sisma del 24 agosto 2016*, 15 settembre 2016.

ISTAT, 2017, *Movimento turistico in Italia, anno 2016,* Statistiche Report, 30 ottobre 2017.

Kaltenborn, B. & Bjerke, T., 2002, “Associations between environmental value orientations and landscape preferences”, *Landscape and Urban Planning,* Vol. 59, Issue 1, 1 March 2002, 1-11.

Mugnano, S. & Carnelli, F., 2016, A “New Normality” for Residents and Tourists: How Can a Disaster Become a Tourist Resource?. In: Bellini N., Pasquinelli C. (eds.), *Tourism in the City. Towards an Integrative Agenda on Urban Tourism*, London: Springer, 321-332.

Perri, A., 2013, “Residential Roots Tourism in Italy”. In: Roca Z. (ed.) *Second Home Tourism in Europe. Lifestyles issues and policy responses.* Surrey: Ashgate.

Rey-Valette, H., Rulleau, B., Hellequin, A.P., Meur-Férec, C., Flanquart, H., 2015, “Second-home owners and sea-level rise: the case of the Languedoc-Roussillon region (France)”, *Journal of Policy Research in Tourism, Leisure and Events*, 7(1): 32-47.

Roca, Z., 2013, *Second Home Tourism in Europe. Lifestyles issues and policy responses.* Ashgate: Surrey.

Skak, M., 2004, “Restricting Ownership of Vacation Homes”, *Tourism Economics*, 10(4), 435-447.

Tertulliani, A. *et al.,* 2016, *Il terremoto di Amatrice del 24 agosto 2016: effetti nell’area epicentrale e valutazione dell’intensità macrosismica* *attraverso la scala EMS*, Istituto Nazionale di Geofisica e Vulcanologia, GNGTS 2016, Sessione Amatrice, 78-82.

Williams, A.M. & Hall, C.M., 2000, “Tourism and migration: New relationships between production and consumption”, *Tourism Geographies*, 2:1, 5-27.

Websites

http://www.copernicus.eu/main/emergency-management.

12. Assessing Resilience of Mountain Communities Hit by the Central Italy Earthquakes of 2016

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Abstract

Community resilience is "the ability of a system to recover from the effect of a hazard, preserving its essential structures and functions". Psychological aspects have a significant influence on the adaptive capacity of populations hit by natural disasters. Among such aspects, place attachment appears to play an important role.

The well-being deriving from the identification with a place has been acknowledged in literature; the loss of one's own place has devastating effects on the emotional state of individuals.

Studies about natural disasters have largely underlined how such events change the emotional bonds with the territory, but only recently place attachment has been explored as a crucial aspect for maintaining the communities' resilience; most of the papers concerned climate change resilience, very few earthquake resilience.

This chapter aims to contribute to the understanding of the influence of territorial bonds on the social resilience of communities hit by earthquakes.

Data were collected through paper questionnaires, in three small mountain communities of central Italy, about one year after the earthquake of August 24th, 2016. Results show that place attachment was a central value for the three-quarters of the interviewees, despite the seismic hazard, in all three areas.

Findings encourage further investigations in other areas with different territorial settings and urban size, for a better knowledge of the role of place attachment for earthquake resilience.

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Keywords: community resilience, earthquake, place attachment, Italy, Marche region.

Introduction

Between August 24th and October 30th, 2016, a series of exceptional earthquake events took place in the middle part of the Italian peninsula; it was also the strongest seismic sequence in Italy in the last 35 years. The peak shock was recorded on the morning of October 30^{th} with a 6.5 MW (Moment Magnitude of the earthquake, as defined by the United States Geological Survey, www.earthquake.usgs.gov), and its epicenter was near the municipality of Norcia. Such a seismic sequence affected an area of nearly 8,000 square kilometers, and for this reason it is considered the greater natural disaster in Italy over the past decades. The event affected 140 municipalities distributed in 10 provinces and four regions, mostly located at altitudes exceeding 900 meters and with a population generally comprised between 1,000 and 10,000 inhabitants.

The earthquake caused extensive damages to buildings; then, because of the inaccessibility of their homes, most of the residents have been moved to accommodation facilities such as campsites, apartments, Bed-and-Breakfast, or holiday farms. All these facilities are located along the Marche coastline or in areas far from their original territories and with a different landscape compared to their mountains of origin.

These people faced a real diaspora from their territories and had to deal with the disintegration of local communities, which negatively influenced their psychological well-being.

Psychological aspects deriving from the loss of one's place have a significant influence on the adaptive capacity of populations affected by natural disasters, with consequent effects on their resilience.

Resilience, indeed, is defined as "The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (UNISDR, 2009).

Place attachment is an emotional bond, which is not necessarily linked to the relationships with local people (Altman and Low, 1992; Manzo and Perkins, 2006), it exists independently from the sense of belonging to, or integration with, the local community and is expressed through an intense connection to a specific territory.

Such emotional bonds with the territory are more important in small communities, with an economy primarily linked to the territory, compared to larger communities (Verbrugge and van den Born, 2018).

Literature about natural disasters has widely underlined how these events change the emotional bonds with the territory (Reser et al., 2011; Baylan et al., 2018; Verbrugge and van den Born, 2018), but only recently place attachment has been explored as a crucial aspect for maintaining the communities' resilience (e.g. Hulme, 2008; Zwiers et al., 2016; Guo et al., 2018; Bark and Sutherland, 2019; Dannenberg et al., 2019; Haney, 2019; Khanian et al., 2019; Lemée et al., 2019).

Nevertheless, most of the studies concern climate change resilience, and only a few studies approach the influence of place attachment on resilience to earthquakes (see, e.g., Clemente and Salvati, 2017).

The present chapter aims to contribute to the understanding of the influence of territorial bonds on the perceived social resilience of communities hit by earthquakes.

Specifically, the analysis was carried out in three small mountain communities (Visso, Ussita, Castelsantangelosul Nera), located in the Marche region (Italy), hit by the central Italy earthquake, which took place in August 24th, 2016, and affected the regions of Abruzzo, Lazio, Marche, and Umbria.

1. Theoretical framework

Place attachment is closely linked to the sense of community (Tartaglia, 2006). This concept indicates an emotional connection to the territory, which differs from interpersonal relationships with the specific people who live in the same territory (Altman and Low, 1992; Brown and Perkins, 1992; Manzo and Perkins, 2006).

Human beings have always felt the need for private space to defend themselves from the weather and to safeguard the privacy of family affections; from this innate need for security, protection, and confidentiality, the need for a personal home was born (Eibl-Eibesfeld, 2007).

The identification with the landscape as a service for the cultural ecosystem and its relationship with human well-being have been recognized by the Millennium Ecosystem Assessment [MA] (2005). Moreover, landscape definitions include not only objective natural characteristics (Turner, 1989), but also subjective human visions, perceptions, identifications, and memories (Knez, 2006; Knez and Thorsson, 2008; Lewicka, 2008; Stobbelaar and Pedroli, 2011; Knez and Eliasson, 2017). This because people develop a sense of attachment not only physically and spatially, but also through psychological, social, historical, religious, moral, health and cultural parameters (Graumann, 2002; Knez, 2005, 2013, 2016; Knez et al., 2009; Knez et al., 2013; Lachowycz and Jones, 2013; Gunnarsson et al., 2016; Ode Sang et al., 2016; Knez and Eliasson, 2017). We anchor our existence to physical places, meaning that places serve to "situate the parts of our past life" (Casey, 2000).

Therefore, the identification with places (Stobbelaar and Pedroli, 2011) contains both cognitive and emotional processes (Knez, 2014), and this special bond is defined by Rubinstein (1992) as "a set of feelings that refer to a geographical place, which bind a person emotionally to this place according to his role or as an experiential setting ".

According to what expressed so far, many studies suggest that human health and well-being benefit from the natural environment (Lachowycz and Jones, 2013; Bratman et al., 2015).

Studies underlined the adverse effects of the displacement from one's own territory with the creation of various gradations of nostalgia effects, a desire to return home, depression, anxiety, and a sense of insecurity (Costa, 2010); this means that, in the event of a break in the link with the landscape, the identity of the individual may also be threatened and altered. Knez (2014) underlines that these feelings are particularly intense for mountaineer people that show very strong feelings of attachment and affinity to the mountainous territories.

Therefore, it is understandable that a strong place attachment becomes an essential factor for the resilience of a community and then for its return to be functional following an extreme event. To assess the perceived resilience of social communities, it becomes necessary to contemplate the relationship between landscape and human society, being these latter pivotal components of the reference system (Brown et al., 2019).

2. Methods

2.1. Study area

This chapter discusses the results of a specific portion of a broader project on earthquake resilience, which was carried out in the Marche Region, in the municipalities of Visso, Ussita and Castelsantangelo sul Nera (Province of Macerata) (Figure 1); territories strongly affected by the seismic events of August 24th and October 26-30,2016. The three selected towns are quite representative of the typical small cities of a mountain environment in Central Italy, with a low population density (Table 1), and a local economy devoted to agriculture, livestock, and forestry, as well as summer and winter tourism.

City	*Visso*	*Ussita*	*Castelsantangelo sul Nera*
N. Inhabitants	1062	419	260
Surface (Kmq)	100,41	55,3	70,67
Population density	10,6	7,6	3,7

Table 1 - *Demographic data of the three studied cities.* Source: https://ugeo.urbistat.com.

2.2. Data collection

Data collection was carried out approximately a year after the seismic events, in October and November 2017, through the distribution of paper questionnaires to the resident population, both to individuals remained in the cities and to the individuals moved to other locations.

The data collection aimed to sample a percentage of the total population of each studied city comprised between the 10% and the 20%, by using the per-quota non-probabilistic sampling method; a total of 240 questionnaires was obtained (Visso: 120; Ussita: 82; Castelsantangelo sul Nera: 38).

The questionnaire consists of 21 questions (Table 2), with different typologies of answer:

- Single choice;
- Multiple choice;
- Likert scale, with which the interviewed are asked to indicate how much agree with a particular statement (Strongly disagree, Disagree, Uncertain, Agree, Strongly agree);
- Intensity scale (not at all – a little – a medium – enough – a lot);
- Free answer.

1. In your experience, who needed most care in the aftermath of the earthquake?
2. Friends and acquaintances were important to face practical problems after the earthquake.
3. Friends and acquaintances were important to face psychological problems after the earthquake.
4. The earthquake strengthened the friendship in your community?
5. The predisposition to bond with other people was useful after the earthquake?
6. How important was participating in associations and events of your community?
7. What were the major difficulties during this emergency period?
8. Post-earthquake reconstruction what kind of typology should respect?
9. What priorities should guide the post-earthquake reconstruction?
10. What do you consider to be the most effective means of communicating information on a state of emergency?
11. Do you trust communication media?
12. Who would you contact for information?
13. In your opinion, the distribution of information on the risks of the territory is a duty only for the institutions or also for the citizen?
14. If you were displaced elsewhere, what were your most important feelings?
15. If you remained where you lived, what was most important?
16. Your home in what conditions it is, now?
17. Where is positioned your home compared to the city center?
18. After this experience, would you return to live in a non-seismic home?
19. Would it be wiser go living elsewhere?
20. Would you be prepared to take out an insurance policy for your home against earthquakes and natural events in general, in order to continue living in your territory?
21. Could the revival and reconstruction of the community start with the development of a participated emergency plan?

Table 2 - *List of the questions of the questionnaire. Source: authors.*

Figure 1 - *Municipalities involved in the study and affected by the seismic sequence of 24th August and 26-30 October 2016. Source: authors.*

The questions can be grouped into a general part, including the personal information of the people interviewed, and a specific part addressing the topic of the study.

The questions composing the specific part of the questionnaires interest the following themes:

1. *sense of community* – investigating the predisposition of people to help others, to be helped by others, and to make friends;
2. *information and communication* – exploring how much the individual has an interest to participate in the community life and to be an active part of it;
3. *place attachment* – assessing residents' attachment to their territory and how much they wish to remain despite the high level of seismic hazard;
4. *community competence and risk perception* – evaluating individuals' ability to survive and adapt following the earthquake disaster.

3. Results

The sample is mostly represented by individuals under the age of 65 years, with percentages very similar for the three studied areas (more or less 85% for all the three areas) (Table 3); genders are well balanced in the cities of Visso and Ussita, and there is a predominance of the male gender in the city of Castelsantangelo sul Nera (42,1 % of female gender, compared to the 46,7% of Visso and the 50% of Ussita (Table 4).

City / Age groups	Visso	Ussita	Castelsantangelo sul Nera	TOT
< 65 years old	87,5	85,4	86,8	86,7
> 65 years old	12,5	14,6	13,2	13,3

Table 3 - *Age distribution in the studied sample. Source: authors.*

City / Gender	Visso	Ussita	Castelsantangelo sul Nera	TOT
Male	53,3	50	57,9	52,9
Female	46,7	50	42,1	47,1

Table 4 - *Gender distribution in the studied sample. Source: authors.*

This chapter illustrates the results from the questions that can provide information about *place attachment*; specifically, we discuss the results from the questions listed in Table 2 with the numbers 2, 3, 6, 9, 14, and 19.

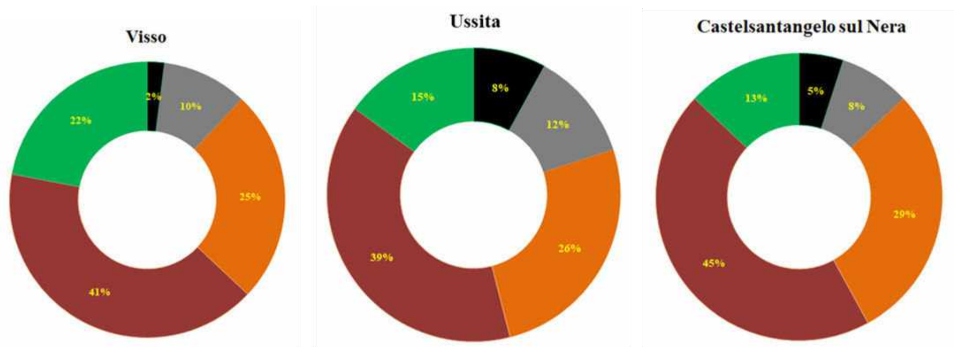
Three of the questions address the aspects related to the social relationships of the respondents in their communities (questions 2, 3, and 6); the other three questions explore the importance given to the territory (questions 9, 14, and 19).

For the respondents, social relationships with individuals of their community are considered crucial in the aftermath of the earthquake event: more than half of the sample in all the three communities *Completely agree* or *Agree* whit the statement that friends and acquaintances were important after the earthquake.

The same result is given both from a practical and psychological point of view (Figure 2, Figure 3).

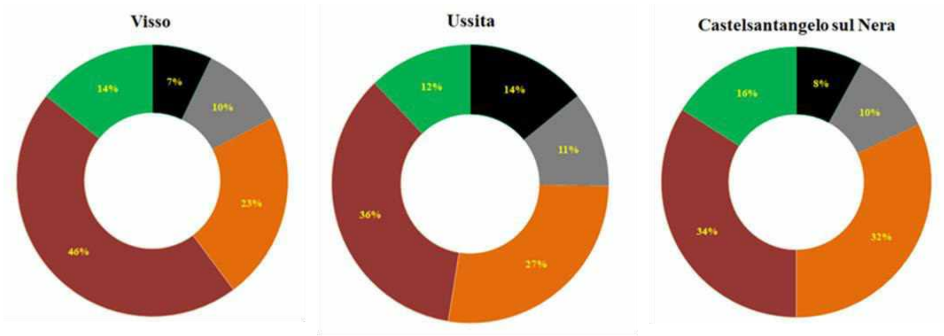
The significance given by the interviewees to the possibility of participating in the social life of their cities confirms the pivotal role of the community (Figure 4).

Indeed, in all the three studied areas almost the three-quarter of the sample declare that this aspect is essential; the amount of the answers *Completely agree* and *Agree* together reach a total of 71% in Visso, 71% in Ussita, and 69% in Castelsantangelo sul Nera.



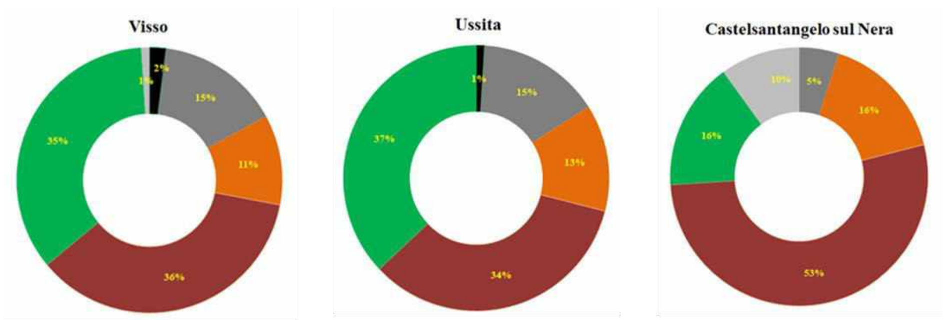
Friends and acquaintances were important to face practical problems after the earthquake?				
Completely agree	Agree	Uncertain	Disagree	Completely disagree

Figure 2 - *Importance of relationships from a practical perspective (Question 2 of the questionnaire). Source: authors.*



Friends and acquaintances were important to face psychological problems after the earthquake?				
Completely agree	Agree	Uncertain	Disagree	Completely disagree

Figure 3 - *Importance of relationships from a psychological perspective (Question 3 of the questionnaire). Source: authors.*



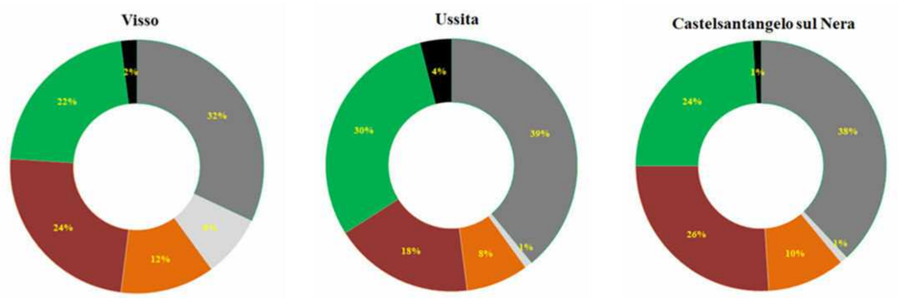
How much is important to participate in associations and events of your community?				
A lot	Enough	A medium	A little	Not at all
No answer				

Figure 4 - *Participation in the social life of the community (Question 6 of the questionnaire). Source: authors.*

About the priorities that should guide the reconstruction strategies, it is interesting to notice that even if the desire to have back the own home is important, it does not reach 40% of respondents in any of the locations. Indeed, the other 60% consider crucial the reconstruction of buildings for work and the social life of the community (Figure 5).

According to the answers provided in Figure 5, the respondents communicate similar nostalgia for their territory to the nostalgia for their homes. This nostalgia for the territory tends to be more important in the smallest community (Castelsantangelo sul Nera). Indeed, *I missed my house,* and *I missed my territory* show 26% and 23%, respectively, in Visso, 24% and 29% in Ussita, 32%, and 23% in Castelsantangelo sul Nera (Figure 6).

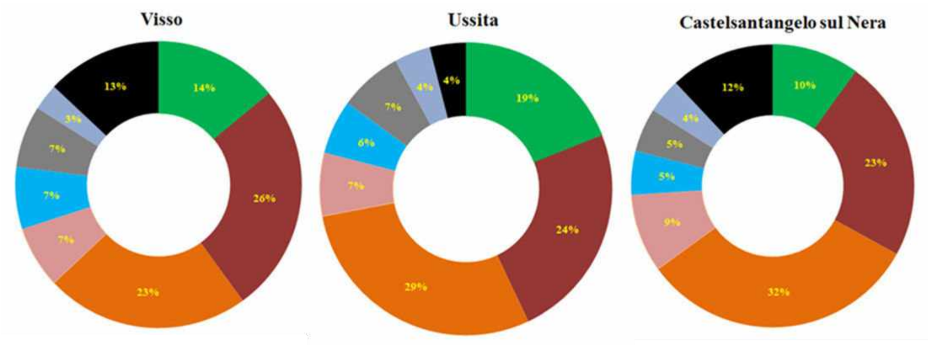
The last question analyzed here asks to the interviewed if they think it could be wiser to go living elsewhere given the unavoidable risk of their territory. As Figure 7 clearly shows, most of the people would prefer to continue living in their territory, despite the hazard and risks characterizing the area, with percentages that reach almost the three-quarter of the sample in all the three cities.



What priorities should guide the post-earthquake reconstruction?				
Manufacturing	Territorial manufacturing	Meeting centers	Houses	Churches
Others				

Figure 5 - *Priorities of reconstruction (Question 9 of the questionnaire). Source: authors.*

For this question, the parental role can represent a significant variable, since a parent should wish more security for its children. Notwithstanding, parents confirm the desire to continue living in their territory with very high percentages in Visso (81,6%), quite high percentages in Ussita (61,1%), and for half of the sample in Castelsantangelo sul Nera (50%) (Table 5).



If you were displaced elsewhere, what were your most important feelings?				
I missed a real house	I missed my house	I missed my territory	The presence of people of my community helped me	The absence of people of my community made difficult the displacement
The whole situation made me wish a definitive relocation	Other	No answer		

Figure 6 - *Feelings of displaced people (Question 14 of the questionnaire). Source: authors.*

For the same question, gender differences did not give different results (Table 6). In Visso e Ussita *Male* and *Female* have similar answer, with about three quarters of the sample that wish to continue living in the same territory; only in Castelsantangelo sul Nera *Female* show higher percentages compared to the other cities regarding the possibility to move away because of the safety of their children (12,5%) or family (12,5%) and the worry for the dangerousness of the territory (18,8%).

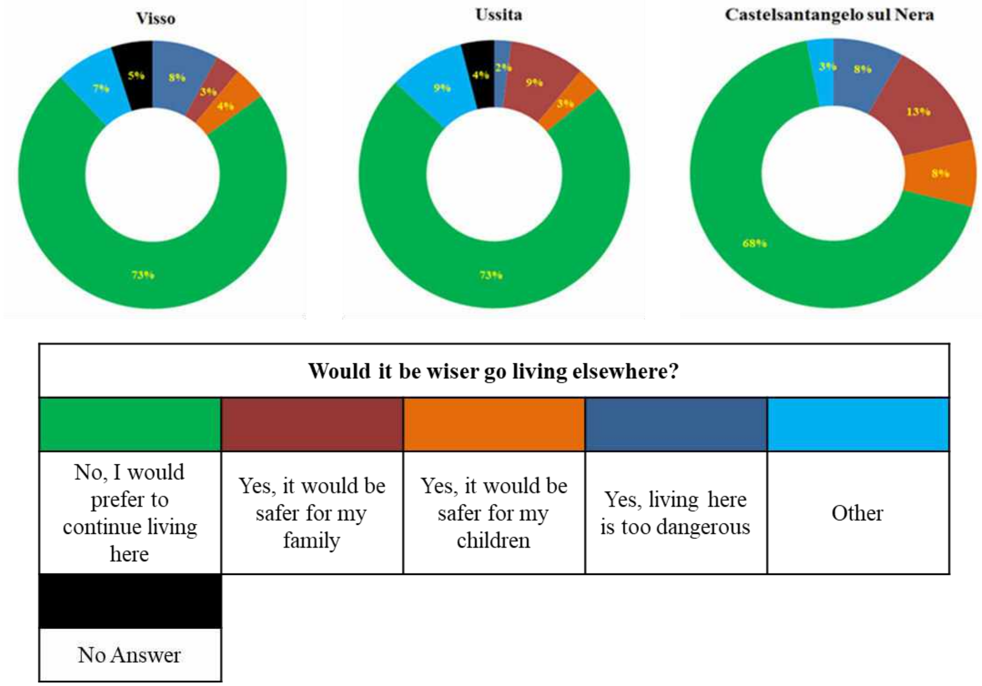


Figure 7 - *Predisposition of interviewed to permanently leave the place because of the earthquake (Question 19 of the questionnaire). Source: authors.*

City	Visso		Ussita		Castelsantangelo sul Nera	
Parental role	P	NP	P	NP	P	NP
No, I would prefer to continue living here	81,6	67,9	61,1	80	50	75
Yes, it would be safer for my family	2	3,7	16,7	3,6	30	7,1
Yes, it would be safer for my children	4,1	4,9	5,6	1,8	20	3,6
Yes, living here is too dangerous	8,2	7,4	5,6	-	-	10,7
Other	4,1	8,6	5,6	10,9	-	3,6
No answer	-	7,4	5,6	3,6	-	-

Table 5 - *Parental perspective (P = Parents, NP = Non Parents) about the predisposition of interviewed to permanently leave the place because of the earthquake (Question 19 of the questionnaire). Source: authors.*

City	Visso		Ussita		Castelsantangelo sul Nera	
Gender	M	F	M	F	M	F
No, I would prefer to continue living here	73,9	72,1	70,5	74,5	86,4	43,8
Yes, it would be safer for my family	2,9	3,3	6,8	10,6	9,1	18,8
Yes, it would be safer for my children	4,3	4,9	4,5	2,1	4,5	12,5
Yes, living here is too dangerous	7,2	8,2	2,3	2,1	-	18,8
Other	7,2	6,6	9,1	8,5	-	6,3
No answer	4,3	4,9	6,8	2,1	-	-

Table 6: *Gender differences about the predisposition of interviewed to permanently leave the place because of the earthquake (Question 19 of the questionnaire). Source: authors.*

4. Discussion and conclusions

Resilience to disasters is a central issue in these last decades; this ability is profoundly affected also by psychological aspects influencing the well-being of the individuals involved in natural disasters.

Since the crucial role of place attachment in maintining the communities's resilience to earthquakes remain less explored, this chapter wants to contribute to a better understanding of this specific link.

Data were collected in three small mountain communities of central Italy, hit by the earthquake of August 24th, 2016, through the use of paper questionnaires.

Results highlight an essential link between the interviewed individuals and their mountainous territories and communities; such a link was not weakened by the occurrence of the dramatic seismic event they experienced.

The majority of respondents from all the three communities would continue to live in their places, despite the seismic hazard and risks. Worth of notice is the irrelevant differences between parents and non-parents in the choice to remain, underlining their desire, as parents, to grow their children in a place that represents the family roots and genius loci (Knez, 2005; Knez and Eliasson, 2017).

Such an aspect is visible only as a gender difference in one of the three areas (Castelsantangelo sul Nera), where women were more inclined to move away, compared to men, because of their family or children.

The displacement from the territory, even a temporary one, is lived by the interviewed with enormous sadness. This powerful emotional link to the territory is corroborated by the fact that the interviewed reported missing more the place than their homes or the manufacturing, albeit also these elements are considered necessary.

Findings, then, suggest that place attachment should be considered a crucial element also for the maintaining of earthquake resilience. This aspect is especially true for planning strategies, as recently underlined by studies concerning climate change resilience (Haney, 2019, and reference therein), since displacement of populations is often a mandatory management measure.

Findings encourage further investigations in other areas with different territorial settings and urban size, for a better understanding of the role of place attachment for earthquake resilience.

References

Altman, I., Low, S.M., 1992, *Place attachment. A conceptual inquiry*. Human Behavior and Environment book series. Springer.

Bark, R.H., Sutherland, P., 2019, "Reconciling place attachment with catchment-based flood risk management: what can we learn from film?",*Journal of Flood Risk Management*, 12(Suppl. 2), e12531. Doi.org/10.1111/jfr3.12531.

Baylan, E., Aşur, F., Şehribanoğlu, S., 2018, "Sense of place and satisfaction with landscaping in post-earthquake housing areas: the case of Edremit TOKI-Van (Turkey)", *Architecture, City and Environment*, 13(38), 31 – 56. Doi.org/10.5821/ace.13.38.5207.

Bratman, G.N., Daily, G.C., Levy, B.J., Gross, J.J., 2015, "The benefits of nature experience: improved affect and cognition", *Landscape and Urban Planning*, 138, 41–50. Doi: 10.1016/j.landurbplan.2015.02.005.

Brown, B., Perkins, D.D, 1992, *Disruption in place attachment*. In: Altman I., Low, S.M. (Eds.), *Place Attachment*, New York: Plenum Press. Doi: 10.1007/978-1-4684-8753-4_13.

Brown, K., Adger, N.W., Devine-Wright, P., Anderies, J., Barr, S., Bousquet, F., Butler, C., Evans, L., Marshall, N., Quinn, T., 2019, "*Empathy, place and identity interactions for sustainability*", Global Environmental Change, 56, 11 - 17.

Casey, E.S., 2000, *Remembering, Second Edition: A Phenomenological Study*. Indiana University Press. JSTOR, www.jstor.org/stable/j.ctt16gzfjf.

Clemente, M., Salvati, L., 2017, "Interrupted Landscapes: Post-Earthquake Reconstruction in between Urban Renewal and Social Identity of Local Communities", *Sustainability*, 9. Doi:10.3390/su9112015.

Costa, M., 2010, *Psicologia ambientale e architettonica, Come l'ambiente e l'architettura influenzano la mente e il comportamento*. Franco Angeli, Milano.

Dannenberg, A.L., Frumkin, H., Hess, J.J., Ebi, K.E., 2019, "Managed retreat as a strategy for climate change adaptation in small communities: public health implications", *Climatic Change*, 153, 1 – 14. Doi.org/10.1007/s10584-019-02382-0

Eibl-Eibesfeldt, I., 2007, *Human Ethology (Foundation of Human Behavior).*Routledge Editor.

Graumann, C.F., 2002, The phenomenological approach to people-environment studies. In*:*Bechtel, R.B., Churchman, A. (Eds.), *Handbook of Environmental Psychology*, Wiley & Sons, New York.

Gunnarsson, B., Knez I., Hedblom M., Sang, Å, 2016, "Effects of biodiversity and environment-related attitude on perception of urban green space", *Urban Ecosystems*, 20, 1, 37 – 49. Doi.org/10.1007/s11252-016-0581-x.

Guo, Y., Zhang, J., Zhang, Y., Zheng, C., 2018, "Catalyst or Barrier? The influence of Place Attachment on Perceived Community Resilience in Tourism Destinations", *Sustainability*, 10, 2347. Doi:10.3390/su10072347.

Haney, T.J., 2019, "Move on or dig in? Risk awareness and mobility plans in disaster-affected communities". Journal of Contingencies and Crisis Management, 27, 224 – 236. Doi: 10.1111/1468-5973.12253

https://ugeo.urbistat.com. Last access 10/11/2019

https://www.earthquake.usgs.gov. Last access 10/11/2019.

Hulme, M., 2008, "Geographical work at the boundaries of climate change", *Transactions of the Institute of British Geographers*, 33, 5 – 11.

Khanian, M., Serpush, B., Gheitarani, N., 2019, "Balance between place attachment and migration based on subjective adaptive capacity in response to climate change: the case of Famenin County in western Iran", *Climate and Development*, 11, 1, 69 – 82. Doi.org/10.1080/17565529.2017.1374238.

Knez, I., 2005, "Attachment and identity as related to a place and its perceived climate",*Journal of Environmental Psychology*, 25, 207–218. Doi: 10.1016/j.socscimed.2017.01.009.

Knez, I., 2006, "Autobiographical memories for places", *Memory*, 14, 359–377. Doi: 10.1080/09658210500365698.

Knez, I., 2013, "How concerned, afraid and hopeful are we? Effects of egoism and altruism on climate change related issues", *Psychology*, 10, 744–752. Doi: 10.4236/psych.2013.410106.

Knez, I., 2014, "Place and the self: an autobiographical memory synthesis", *Philosophical Psychology*, 2, 164–192. Doi.org/10.1080/09515089.2012.728124.

Knez, I., 2016, "Is climate change a moral issue? Effects of egoism and altruism on pro-environmental behavior", *Current Urban Studies*, 4, 157–174. Doi: 10.4236/cus. 2016.42012.

Knez, I., Eliasson I., 2017, "Relationships between Personal and Collective Place Identity and Well-Being in Mountain Communities", *Frontiers in Psychology*, 8, 79. Doi: 10.3389/fpsyg.2017.00079.

Knez, I., Thorsson, S., 2008, "Thermal, emotional and perceptual evaluations of a park: cross-cultural, and environmental attitude comparisons", *Building and Environment*, 43, 1483–1490. Doi: 10.1016/j.buildenv.2007.08.002.

Knez, I., Thorsson, S., Eliasson, I., 2013, "Climate change: concerns, beliefs, and emotions in residents, experts, decision makers, tourists, and tourist industry", *American Journal of Climate Change*, 2, 254–269. Doi: 10.4236/ajcc.2013.24025.

Knez, I., Thorsson, S., Eliasson, I., Lindberg, F., 2009, "Psychological mechanisms in outdoor place and weather assessment: towards a conceptual model",*International Journal of Biometeorology*, 53, 101–111. Doi: 10.1007/s00484-008-0194-z.

Lachowycz, K., Jones, A.P., 2013, "Towards a better understanding of the relationship between green space and health: development of a theoretical framework", *Landscape and Urban Planning*, 118, 62–69. Doi: 10.1016/j.landurbplan.2012. 10.012.

Lemée, C., Fleury-Bahi, G., Navarro, O., 2019, "Impact of Place Identity, Self-efficacy and Anxiety State on the Relationship Between Coastal Flooding Risk Perception and the Willingness to Cope", Frontiers in Psychology, 10, 499. Doi: 10.3389/fpsyg.2019.00499.

Lewicka, M., 2008, "Place attachment, place identity, and place memory: restoring forgotten city past", *Journal of Environmental Psychology*, 28, 209–231. Doi: 10.1016/j.jenvp.2008. 02.001.

Manzo, L., Perkins, D., 2006, “Finding common ground: The importance of place attachment to community participation and planning”, *Journal of Planning Literature*, 20, 335–350. Doi.org/10.1177/0885412205286160.

MillenniumEcosystemAssessment [MA], 2005, *Ecosystems and Human Well-Being: Synthesis*. Washington, DC: Island Press.

Ode Sang, Å.,Knez I., Gunnarsson, B., Hedblom, M., 2016, “The effects of naturalness, gender, and age on how urban green space is perceived and used”, *Urban Forestry & Urban Greening*, 18, 268–276. Doi: 10.1016/j.ufug.2016.06.008.

Reser, J.P., Morrissey, S.A., Ellul, M., 2011, The threat of climate change: Psychological response, adaptations, and impacts. In: Weisbecker, I. (Ed.), *Climate change and human well-being*, Springer.

Rubinstein, P. L., Parmelee, P.A., 1992, Attachment to place and the representation of the life course by the elderly. In: Altman I., Low, S.M. (Eds.), *Place Attachment*, New York: Plenum Press. Doi: 10.1007/978-1-4684-8753-4_13.

Stobbelaar, D.J., Pedroli, B., 2011, “Perspectives on landscape identity: a conceptual challenge”, *Landscape Research*, 3, 321–339. Doi: 10.1080/01426397.2011. 564860.

Tartaglia, S., 2006, “A preliminary study for a new model of sense of community”, *Journal of Community Psychology*, 34, 25–36. Doi.org/10.1002/jcop.20081.

Turner, M.G., 1989, “Landscape ecology: the effect of pattern on process”, *Annual Review of Ecology, Evolution, and Systematics*, 20, 171–197. Doi: 10.1146/annurev.ecolsys.20.1.171.

UNISDR. *Terminology on Disaster Risk Reduction*. Geneve; 2009.

Verbrugge, L., van den Born, R., 2018, “The role of place attachment in public perceptions of a re-landscaping intervention in the river Waal (the Netherlands)”, *Landscape and Urban Planning*, 177, 241 – 250. Doi.org/10.1016/j.landurbplan.2018.05.011.

Zwiers, S., Markantoni, M., Strijker, D., 2016, “The role of change-and stability-oriented place attachment in rural community resilience: a case study in south-west Scotland”, *Community Development Journal*, 53, 2, 281 – 300. Doi:10.1093/cdj/bsw020.

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Increasingly, socio-natural risks and disasters represent the result of an unsustainable interaction between human beings and environment. The current scientific debate has generally agreed on the idea that the impact of natural hazards needs to take into account the social vulnerabilities and exposures to risk of the affected population. The most recent earthquakes have unequivocally shown the complexity of the phenomena and their multi-scale dynamics. Indeed, the territory is the combination of natural, social and cultural environment and only by exploring its anatomy and physiology, it will be possible to manage and protect it in the best way.
This volume collects a quite wider range of national and international case studies, which investigate how socio-natural risks are perceived and communicated and which strategies the different communities are implementing to mitigate the seismic risk. This publication has been possible thanks to a fruitful discussion that some scholars had at the 36th General Assembly of the European Seismological Commission held in Malta from 2 to 7 September 2018.

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