Chapter 3
Recovery, Development Programs, and Place-Based Reconstruction Policy: A Flexible Framework

Federico Fantechi and Marco Modica

Abstract Hazards, territories, and communities are not all the same and the relation between these objects might result in post-event fuzzy scenarios that will increase the complexity of reconstruction activities in the aftermath of extreme events. Thus, risk might be dependent to territories according to their socio-economic exposure, vulnerability, and resilience turning into a scattered socio-natural disasters scenario. It results that serious considerations need to be devoted to the "optimal" reconstruction policies to be implemented in order to recover quickly since several shortcomings in the management of reconstruction activities are still unsolved. This chapter proposes a flexible framework to operationalize the steps for recovery in the aftermath of extreme events and in different contexts and to prompt for reconstruction and development policies. Indeed, granted that fitting actions and policies are put into action during the recovery phase, the aftermath of a natural disaster might represent a small window of opportunity for a turning point in the development path of the affected communities. Aiming at empowering and supporting communities affected by natural disasters, this chapter presents and discusses a Context-Bound Framework for Resilience not only as a "framework for research" but also as a "framework for action." Providing policy and investment information ex-ante such framework allows policy makers to immediately outline strategies to improve the ability of community resilience of the territories, affecting both the reconstruction process and their development path.

Keywords Resilience · Place-based · Socio-natural disasters · Reconstruction · Development programs · Recovery

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1 Introduction

Disasters triggered by natural phenomena are one of the biggest problems that a society needs to address, today and in the near future. Only in the last decade, an average of 354 disastrous events were registered around the globe, affecting more than 2 billion people and causing the death of almost 78,000 (Below & Wallemacq, 2018). A wide range of natural phenomena such as tsunami, landslides, floods, hurricanes, fires, and droughts occur almost daily in different parts of the globe. This is particularly worrying in the light several studies assessing the impact of climate change on the specific types of climate events (e.g., droughts, rainfall, cyclones). Such studies have shown a positive correlation between climate change and the magnitude and probability of these events (NAP, 2016; Stott, 2016). Nonetheless, the occurrence of such events alone does not make a disaster. Natural events become disasters when they affect man-made territories and the communities living in those areas (Mela, Mugnano, & Olori, 2017)—that is when a destructive force (nature) meets the built environment with its social and economic structure (society).

Since the turn of the century and the publication of the Hyogo Framework for Action[1] the topic of reconstruction and development has risen the public attention, much has already been done in order to reduce damages and to improve the effectiveness of the recovery process caused by natural hazards with the complicity of society.

In fact, it is very well-known that socio-natural disasters affect both the built environment and the social and economic structure, causing—in addition to the human losses and damages to infrastructure and buildings—also huge economic losses.[2] However, despite an enormous loss, for some territories and communities—especially those locked-in to an underdevelopment path (Belmonte, Bove, D'Inverno, & Modica, 2019; Martin & Sunley, 2006; Wilson, 2014)—socio-natural disasters can also be thought as the trigger for positive opportunities that allow to contrast negative trends and eventually revert a dependency path. Indeed, disastrous events generate a temporary window of opportunity by "suspending the everyday life" and disrupting the economic and social structure of communities (Berger & Luckmann, 1966; Modica, Faggian, & Aloisio, 2019). Granted that fitting actions and policies are put into action during the recovery phase, this temporary window of opportunity might represent a turning point in the development path of these communities. Metaphorically speaking a community might be seen as a river, flowing onto its riverbed (the dependency path), clearly it is not easy to alter its course because the water won't stop flowing and push it to take a different path will require an extreme effort. Nonetheless, it is possible to disturb the system by rolling a big

[1] The Hyogo Framework for Action 2005–2015 (UNISDR, 2005) is the precursor of The Sendai Framework for Disaster Risk Reduction.

[2] The Centre for Research on the Epidemiology of Disasters (CRED) estimates that disastrous events caused an economic loss of almost 1.5 trillion US$ in the last decade, and 334 billion US$ only in 2017 (Below & Wallemacq, 2018).

rock into the river that stops the water flow (this is the suspension of the everyday life caused by the disaster, see Modica, Reggiani, & Nijkamp, 2017 for a study on the evolution of urban systems). Therefore, we will have a temporary window of opportunity—to modify the, now dry, riverbed and create a new path for the water to flow (temporary because the water will soon overcome the rock or start flowing out of its riverbanks).

With a due considerable increase in complexity, the same applies to communities and their development paths. For both the river and communities two are the key elements at work in this process: the suspension of everyday life and a focused effort to ease, encourage and drive both the water and the communities towards a new path. While it cannot be predicted nor controlled, the occurrence of disastrous events causing this suspension of everyday life, the actions can be controlled and the effort put in place to drive the affected communities towards different paths.

This emerging trend of linking disasters' recovery and development programs (Modica, Faggian, & Aloisio, 2019) is embedded and perfectly represented in the Sendai Framework for Disaster Risk Reduction 2015–2030 (Aitsi-Selmi, Egawa, Sasaki, Wannous, & Murray, 2015). With the explicit aim of enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction, the Sendai Framework aims at connecting disaster' recovery and development programs and builds resilient communities and nations.

This chapter focusing on the local level via the use of the concept of *community resilience* proposed a framework to build connected recovery and development programs. Such framework emerges from the meeting point between the evolutionary perspective in economic geography (Martin, 2011; Modica & Reggiani, 2015; Wilson, 2014) and the community-centered perspective of place-based approach (Barca, McCann, & Rodriguez-Pose, 2012) underlining the central importance of historical and geographical processes in delineating how resilience is differently composed among different communities. Building on this literature, a *Context-Bound Framework for Resilience will be proposed* which produces the specific results tailored for the specific case studies while maintaining a generalizable research strategy and design.

2 Community Disaster Resilience

In its most general meaning, resilience is defined as the ability to react after some kind of stress. With the use of different, and more specific, definitions the concept is, then, adopted in many disciplines from psychology to ecological studies, sociology, natural disaster studies, geography and, of course, economics.

The word of resilience itself is not a specific term of any field in social sciences, it was imported from physics during the 1970s where it describes the ability of a material to bend and then bounce back to its original equilibrium, rather than breaking after a stress is applied (Bodin & Wiman, 2004; Wilson, 2014). Since its first application in social sciences (Holling, 1973), it is clear that the concept of

resilience was used as a powerful metaphor linking the study of humans to the one of materials, linking studies in social sciences to those in physical sciences.

It is believed that the resilience is today a very prolific paradigm across many disciplines which, once detached from its metaphorical imagery, can unfold a great potential.

2.1 Concept Definition

Over time, and across different fields, the concept of resilience has been framed—and defined—in many ways. The most prolific of these frames is probably the one of *regional resilience*,[3] which receives most of its contributions from the fields of economic geography (Carpenter, 2015; Christopherson, Michie, & Tyler, 2010; Martin, 2011; Modica & Reggiani, 2015; Simmie & Martin, 2010) and disaster studies (Carpenter, 2015; Cutter et al., 2008; Mayunga, 2007). As argued in Faggian, Gemmiti, Jaquet, and Santini (2018), most of these contributions focus on the traditional economic indicators and fail in representing the complexity of the social world. A very similar—and still very prolific—framework, proposed from more sociological contributions, is the one of *community resilience*; this approach, largely used not only in sociological studies but also in studies on natural disasters, focuses on trying to capture resilience along a series of sub-dimensions of the social structure (Faggian et al., 2018), highlighting the complexity of society and making it a key strength of the approach. In more details,

Norris et al. (2008, p. 130) define community resilience as

> Dynamic process composed by many adaptive capacities to response and change after adverse events.

This definition has indeed many advantages. Other than being light, communicative and very adaptable to different fields, it connects the evolutionary perspective and complex nature of resilience composing the two pillars of our *Context-Bound Framework*.

First, it defines the resilience as a dynamic process—rather than simply an ability—underlining how it is not fixed in time but is sensible to the temporal dimension. Finally, this definition stresses that resilience is composed by many adaptive capacities, highlighting the complex nature of such process.

[3] Linking the concept of resilience to the spatial dimension.

2.2 An Evolutionary Perspective on Resilience

Very recently, the application of notions from Evolutionary Economic in the field of Economic Geography gave birth to a research approach where space and time are the two main actors (Boschma & Martin, 2010). Right from the start, the goal of EEG wasn't only to incorporate historical processes in explaining how the economic landscape change, but also to show how "*situating the economy in space adds to our understanding of the processes that drive economic evolution, that is to say, to demonstrate how geography matters in determining the nature and trajectory of evolution of the economic system*" (Boschma & Martin, 2010 p. 6).

The main focus of this theoretical approach is the spatiality of economic novelty but the ideas they propose can be extended way off this specific field. Geography and history do matter and can sometimes be a sentence for regions and communities that find themselves locked-in in lagging situations or in underdevelopment paths (Boschma, 2015; Simmie & Martin, 2010). Exogenous shocks play a very interesting role over such spatial and historical paths. With a common evolutionary approach sociologists and anthropologists have long studied how proto and early human societies evolved and developed (Turner & Maryanski, 2013), finding out that facing difficult situations is a powerful trigger for social change and adaptation. Large-scale events like socio-natural disasters affecting entire communities therefore will generate ruptures in the social structure (Corbo, Corrado, & Ferriani, 2016; Sine & David, 2003). The occurrence and consequences of exogenous shocks play a key role in suspending what Berger and Luckmann call "the everyday life" (Berger & Luckmann, 1966) of communities, thus exposing rules and practices that had been taken for granted. Organizational studies (Powell, White, Koput, & Owen-Smith, 2005; Corbo et al., 2016) suggest that during these difficult moments there are increased chances for social change and reshaping equilibriums in the social structure (Thornton, 2002). Since the beginning of history, human society has been shaped by our reactions and adaptations to exogenous and environmental shocks. Evolutionary theory suggests that, over immensely long periods, the adaptation to these events triggered the evolution of our species (Hoffmann & Hercus, 2000).

The events and processes we analyze are "smaller" but act on the affected communities in the same way. Ruptures in the social structure are particularly effective on vulnerable communities, struggling to keep the pace with the complexity of contemporary social and economic structures (Devitofrancesco et al., 2016). Connecting recovery and development paths, the aftermath of a natural disaster can be channelled in becoming an opportunity (Fantechi, Urso, & Modica, 2020) for change and adaptation. Being a resilient community means being able to exploit these opportunities to change and adapt, to "bounce forward" (Martin & Sunley, 2006). In this perspective, both time (history) and space (geography) not only matter but are the key actors in delineating the different specificities of resilient communities.

2.3 Resilience of What to What?

Starting from the definition itself, it presents resilience as a process involving two different actors: the *community* (in the definition the implicit subject holding the "*many adaptive capacities"*) and the *adverse events*. An adverse event can indeed take place in many different ways for example, consider how different a flood or an earthquake could be. Moreover, what about a community hit by, for example, an epidemic or an economic crisis? The triggering phenomenon is not natural, but does it mean that it is not an *adverse event*? Of course, not. It is an adverse event, one which takes place in a very different way from one triggered by a volcanic eruption.

The other actor, the community, involved in the process makes things even more complex. It's easier, here, to understand how communities are different between themselves. Indeed, different communities will have—and will make different use of—different *adaptive capacities*. Depending on the space they are situated in the world, different societies, cultures, and economies embedding them, communities will have different sets of adaptive capacities composing—or not—their ability for to be resilient. Moreover, even inside the same society or geographic area sensible differences and sets of the adaptive capacities can be found.

The number of possible interactions of these two groups of objects creates enough complexity around the *dynamic process* of resilience for a single solution to work in different situations. In order to achieve the same goal—being resilient—different communities in different situations (affected by different adverse events) will require the support of different strategies, implementations, and policies.

Is it impossible then to develop a unified strategy to build better resilient communities? The answer is both yes and no. Indeed, while it is impossible to develop a *single solution* working for all different scenarios, we can create a *unified strategy*.

In the next sections, a framework will be presented to approach the linked problems of recovery and development processes together over different scenarios with a unified strategy. Instead of focusing on the *solution*, our framework is focused on the communities, pushing for the implementation of place-based solutions drawn out from the specificities and needs of the communities themselves (Barca et al., 2012). It is important to say that, in the disaster risk management, much attention is focused on the emergency phases and many countries own more or less effective civil protection systems able to cope with the extreme events and implementing "codified" actions. This is not the case for post-emergency situations where reconstruction and development have to be fostered. This claims for a "codified" post-emergency system of actions that, given what expressed before, needs to take into consideration the local characteristics of the places in relation to the affected natural event and suffered damage.

The *unified strategy* to build better the resilient communities is not found in the solution rather in the process of finding the different solutions for different scenarios. From a theoretic point of view, this strategy is perfectly represented by the question:

"Resilience of what to what?"[4] Answering this question will, indeed, force to develop and apply place-based solutions tailored to the interested communities. An example of what—answering this question—implies is noteworthy. Consider two different communities affected (for the sake of simplicity) by the same adverse event (e.g., a major hydrogeological event). The first community is an urban industrialized community of a developing country. The other is a rural community of a rich country with a local economy based on agriculture and rural tourism. The first community (the urban one) is a dynamic and growing community, highly densified, with many production sites attracting people, young people especially, from all the surrounding areas thanks to the working opportunities. On the other hand, the second community (the rural one) will likely be a less dense community, highly sprawled over the jagged, not uniform territory, whose economy is composed mostly by family-owned farms and small activities. The internal demographic situation will likely be different as well, with the second community possibly suffering from decades-long processes of depopulation and aging of the community (and we are not even touching the difference in social capital and administration, to keep thing simple).

It is easily understandable how the ability for resilience of the two communities will be not only different in terms of the strength of their adaptive capacity, but also in their composition. What is less clear—and here is the bedrock of the framework we will propose—is that *being resilient* in response to adverse events has a different meaning for these two communities. In other words, the empirical definition of resilience changes between the two scenarios. So, while the two communities will have some common goals like reconstructing (and improving) buildings and damaged infrastructures, resilience is something more than this. The first community—in order to become more resilient—will focus on the economic and productive sector, and on building policies oriented to improve the dense living situation. In this scenario, the empirical definition of resilience will be correlated to these needs and will be composed by, let's say, an economic indicator.

Applying the same empirical definition of resilience—and the same measurement—to the scenario of the second community, won't bring any useful results. Indeed, the empirical definition in this second scenario will likely be focused on different dynamics and different needs emerging from the community themselves. Concluding the example, a more appropriate measurement of resilience for the second scenario will include demographic indicators, rather than economic ones, as well as their strategies and policies will focus on attracting more—and why not, young—people to live and work there.

The framework proposed in the following sections, rises from this complexity and, orienting itself towards a place-based approach, it gains strength from it. Indeed, having different—and not fixed in stone—empirical definitions of resilience suitable to different scenarios will be the starting point to study the past, develop the tailored strategies in the present, and build more resilient communities for the future.

[4] The question, here used to introduce the process of traducing the concept into a heuristic definition, has been proposed already in similar fashion in a paper from Carpenter, Walker, Anderies, and Abel (2001).

3 Different Paths for Different Needs

For what it can be summarized, four actions need to be implemented in order to recognize the different paths and different need in the aftermath of a natural disaster: first, the phenomenon has to be properly recognized; second, the formal investigation on the degree of susceptibility (when we need more simple and fast kind of probability assessments) and hazard (full probabilistic models); third, defining the effective risk for the population given their exposure, vulnerability, and resilience characteristics; finally, formal place and hazard types of mitigation actions need to be implemented (Iovino, D'Emidio, & Modica, 2020). However, after an extreme event, very immediate actions are typically developed in order to shape the emergency interventions and to define the structural lines of the future reconstruction activities, identifying the types of building damages, the damage compensation to the affected population, and the financial framework sufficient to ensure the continuity of interventions in all the phases of emergency and post-emergency, often without a legislative framework of reference and without considering the disaster history of the affected country. This intense legislation work might sound hard to digest, especially in relation to highly affected countries by natural disasters. However, as mentioned before we are convinced that the natural disasters are not intrinsically the same "between" and "within" them. For instance, hydrogeological damages such as those caused by landslide and floods are different from those caused by volcanos eruptions or earthquakes, and, on the same line, even by considering the same hazard —e.g. the damages caused by earthquakes — these might differ according to the magnitude of the events and for the different characteristics of the areas and communities affected by those events. Furthermore, also when analyzing the effect of extreme events, these are not the same even if caused by the same extreme event because of the different socio-economic conditions of the area affected. Some examples are provided in the next sub-section.

A flexible legislative framework would be therefore pivotal in order to avoid delays in reconstruction activities and confusion in skills and tasks of the stakeholders involved in the reconstruction.

3.1 The Italian Examples

Italy is very seismically active but is also one of the most exposed European country for the impact of meteorological phenomena, like flash floods, tornadoes, droughts, and so on (Guidoboni & Valensise, 2013). Italy is therefore a good example in order to address many important issues in the disaster risk management and in the capacity to shape framework identifying the different paths for different needs.

An example is here provided that derives by the effects of two similar earthquakes (in magnitude) that affected Italy in a short period: the Northern Italy earthquake of 2012 and L'Aquila earthquake of 2009. As mentioned above they have

almost the same magnitude; however, they provide very different effects that turns into two different reconstruction models. The 2012 event affected large municipalities and especially their productive facilities in an economically relevant area of the country. The 2009 event instead affected low-density and small municipalities, many of those might be considered as "inner areas"[5] showing a below-average per capita income. Implemented reconstruction policies have thus been quite different often requiring very dissimilar reconstruction interventions in order to ensure and to promote the local development of territories presenting very peculiar and somehow opposite socio-economic features, even if they were affected by "almost" similar event. The 2012 event has acted as a stimulus for the introduction of reconstruction strategies to foster: (1) an increase in the flexibility of the affected firms; (2) the search for new markets; (3) better safety practices; and (4) a greater compliance with the existing regulation, while the 2009 event has acted as a stimulus for rebuilding residential houses and reducing the vulnerability of buildings to seismic risk.

The two earthquakes, even though similarities in the magnitude of the events, affected very different areas of the country. The three affected regions of the Northern Italy earthquake (Emilia-Romagna; Lombardy and Veneto) are considered the economic most developed regions of Italy. The estimated damages were around 13 billions of euro, and the productive system was highly affected. Therefore, the reconstruction had the necessity to be quick in order to allow the productive continuity of the system, with the residential necessity put on the back burner.

Similar damages, at least in monetary terms, have been estimated for the L'Aquila earthquake, even if the reconstruction activities were in some sense slower than the Northern Italy earthquake, with a particular focus on the residential activities in a rural context. Even if some peculiarities arise in this context, 4% of the total reconstruction funds are devoted for the development of the area affected, with the idea that L'Aquila will turn in a "city of knowledge" (OECD, 2013).

Furthermore, as denoted by two different case studies provided above differences in the relationship between degree of rurality and seismic risk might be relevant. The distribution of risk by areas (central or inner) denotes a certain asymmetry, especially with reference to the seismic risk, with a concentration in most remote, mountainous areas, underlining in this way, a potentially different pattern of reconstruction activities between different socio-economic areas—dramatically captured by the very well-known urban/rural divide.

Therefore, local administration has to play a central role and full responsibility in achieving the reconstruction goals but the reconstruction remains a multi-level governance process involving all actors, i.e., municipalities, provinces, and regions, with the guidance of the national administration and other coordinating structures. The new reconstruction setting should be based on the centrality of the affected territories in the reconstruction process and on the socio-economic revitalization of the areas.

[5] Italian classification for rural municipalities. Rural municipalities are defined as "inner areas" and classified over three categories: intermediate, peripheral, and ultra-peripheral (Lucatelli et al., 2014).

3.2 Building Place-Based Resilient Community Strategies

In order to achieve the goal of creating resilient communities, multi-level reconstruction settings should aim at (1) reducing future risks (2) triggering development growth of the areas affected.

Unpacking the concept of resilience into these two aims helps us to partially reduce the complexity of it, so that the separate frameworks can be delineated for actions. Future risks reduction, when looking at the mitigation actions, is directly connected to the type of natural hazard involved. The socio-economic characteristics play a less relevant role, especially so in the planning activities of mitigation actions that do not require different strategies when facing similar kind of hazard in different communities. In other words, when planning for risk prevention, the socio-economic characteristics may create the different inherent conditions but, in the end, from hazard to hazard and from community to community, the socio-economic goals for risk mitigation does not change. Different strategies for mitigation actions are instead driven by the differences "between" socio-natural disasters. Mitigation actions are, hence, primarily ecological and infrastructural issues and their strategic goals are connected mostly with the nature of the hazard. For the implementation of mitigation actions therefore, the socio-economic characteristics of an area are only of residual importance.

On the contrary instead, planning for the recovery of a community (aiming to trigger a positive development path or keep it onto one) is unaffected by the type of natural hazard.[6] Indeed, in a recovery program, the strategies and goals should be the same regardless the hazard. What drives these strategies are instead the socio-economic differences of the area. Most importantly, these differences shape different goals for the recovery program. When the aim is to trigger a positive development path, recovering after a natural hazard, strategies and goals will not change whether the area was affected by an earthquake or flood. Different strategies for the recovery are instead driven by the differences in socio-economic characteristics of the community. This is what we previously called differences "within" socio-natural disasters. Here lays most of the complexity of the concept of resilience. Figure 3.1 is a summary of this complexity.

Resilience and vulnerability (the reduction of possible risks) are two concepts often dealt together. For a long period, scholars discussed if these two concepts were complementary, one the opposite of the other, or conflicting among each other (Miller et al., 2010). The two concepts are connected, and we could say somehow complementary. Sure it is, they are neither conflicting nor one the opposite of the other. They are connected, yet very diverse and should not be treated in the same way.

[6] It is important here that the aforementioned "recovery of a community," does not include those activities put into action in the first emergency phase and in the subsequent reconstruction phase. Indeed, actions and programs put into action for the physical reconstruction after a natural disaster are widely differentiated by the type of natural hazard. Recovery policies instead focus on the socio-economic structure of a community.

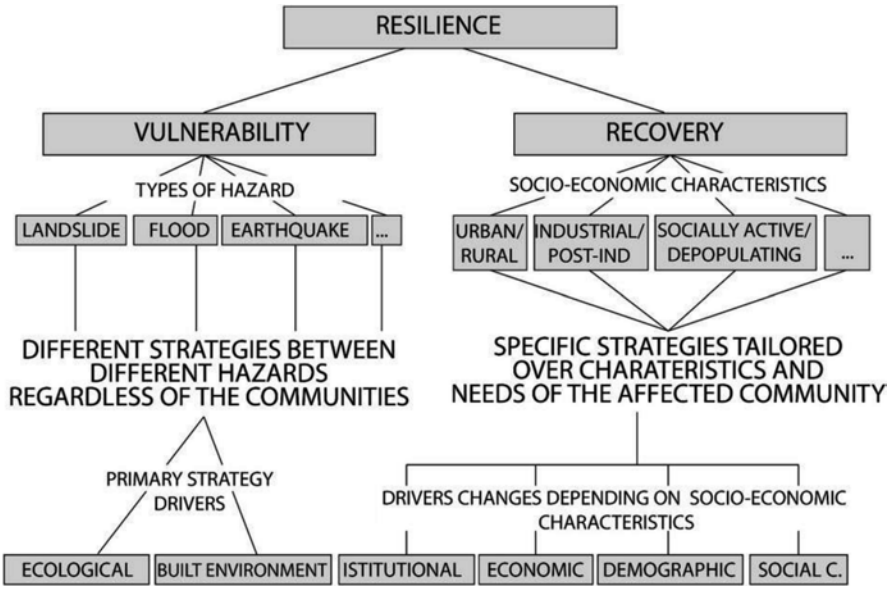

Fig. 3.1 The complexity of resilience concept: concepts and drivers

In delineating a framework for recovery and development paths, both resilience and vulnerability need to be addressed and integrated. Indeed, both are key elements to build communities able to cope, change, and adjust facing up the challenges posed by natural disaster and socio-economic processes.

Despite this interconnectedness, strategies and tools to build towards, one or the other are very different. In order not to confuse them, while addressing both of them, the two paragraphs below will discuss them separately.

4 Framework for Risk Evaluation

A framework for disaster risk assessment and disaster risk prevention is under evaluation in the last years. Disaster risk is a complex concept that encompasses several different aspects of the disasters risk management. It roughly means "*the possibility of adverse effects in the future*" (p. 69, Cardona et al., 2012) as the result of interaction between social and environmental processes that can be summarized by concepts such as physical hazards, exposure, vulnerability, and resilience (Cardona et al., 2012). In fact, it has long been recognized that the hazard event is only the trigger of the risk but it provides more or less effects according to the exposure, vulnerability amd resilience of societies and more general social-ecological systems (Cardona, 2011; UNDRO, 1980; UNISDR, 2011). Therefore, disaster risk can be seen as a function of:

$$R = f\left(H,E,V,\text{Res}\right)$$

It is possible to argue about the right function form of this expression; however, it is possible to recognize it as:

$$R = \frac{H * E * V}{\text{Res}}$$

Therefore, in any disaster risk evaluation of local areas or regions, what it is important in order to take a series of right actions that not only promote the risk mitigation or preparedness, but also the capacity of bounce back or even to improve the development of areas after an extreme event, knowledge on any of these concepts should be taken into deep consideration.

In order to provide an example of the information required for allowing an accurate risk assessment, we rely on three previous works of us that focus on Italy as a case study. Modica and Zoboli (2016) provided the clues on the understanding of the socio-ecological framework for natural disaster analysis. Clearly any socio-economic environment that is contingent to nature might be seen as integral to nature. Hazard per se belongs to the realm of the natural system that can be only indirectly affected by the socio-economic system—think about the effects of global warming on the frequency and magnitude of extreme natural events (LaFontaine et al., 2019; Stott, 2016; Ummenhofer & Meehl, 2017). Instead, exposure, vulnerability, resilience and therefore risk are in between the natural and the socio-economic realm. Exposure can be divided into natural resources or human resources and it is affected by the socio-economic system and by the institutional setting as well as vulnerability and resilience. Essentially, it takes into consideration all the objects that can be affected by a hazard and how it can produce more, or less, damages. What is trickier to understand in a risk analysis framework is the role played by vulnerability and resilience. To our understanding, vulnerability and resilience share common characteristics but they are not interchangeable. Vulnerability might be seen as the intrinsic capacity of a socio-economic context to "suffer" damage and it can be interpreted as the socio-economic characteristics of the areas under analysis that could drive the intensity with which the hazard impacts (e.g., the aging of physical infrastructure or the wealth of the regions). Resilience instead, from a wide perspective, is the capacity to recover and adapt after the extreme event. It is important to underline that in our view, increasing the socio-economic resilience of the regions does not prevent the possibility to suffer damage nor to reduce the impact the hazards (as could derive when reducing the vulnerability) but only to recover and to better and more quickly adapt to changes without any "external help." As an example, institutional capacity is definitively a resilient component because it increases the possibility of the affected areas to better coordinate the reconstruction process after a disaster (Naheed & Eslamian, 2021).

Therefore, vulnerability and resilience are moving in the opposite direction—e.g., an increase in vulnerability increases the risk, while an increase of resilience reduces the risk (and this is why we put resilience in the denominator of the equation above). However, in a risk evaluation framework, improving the resilience of the communities will take a long time and carefully planned and monitored public policies. However, analyzing the resilience at a given point of time might provide useful insights in order to assess the risk of the selected areas and underline which areas are—at least in relative terms—more risk-prone. This will return in a map of places that deserve further attention because the occurrence of an extreme event can cause the high unrecoverable damages (see also Marin, Modica, Paleari, & Zoboli, 2019).

Then, disaster risk, in a restrictive interpretation, is the combination of hazard (e.g., frequency and magnitude of natural events), the elements exposed that own a different degree of vulnerability and resilience, that somehow are more pronounced according to the unequal effects of public policies especially so when unplanned and disorganized reconstruction activities take place. Figure 3.2 provides a sort of summary for what said above. Risk is definitively a combination of natural and human environment and exposure, vulnerability and resilience—that are mainly the human characteristics of the places but in some cases also the natural resources—(e.g., think about natural amenities and their impact on the tourism) are aspects able to turn a hazard in a higher or lower damage. However, public policies are able to affect any of these three components (e.g., defining more restrictive building standards). Addressing singularly these concepts provides a unique source of

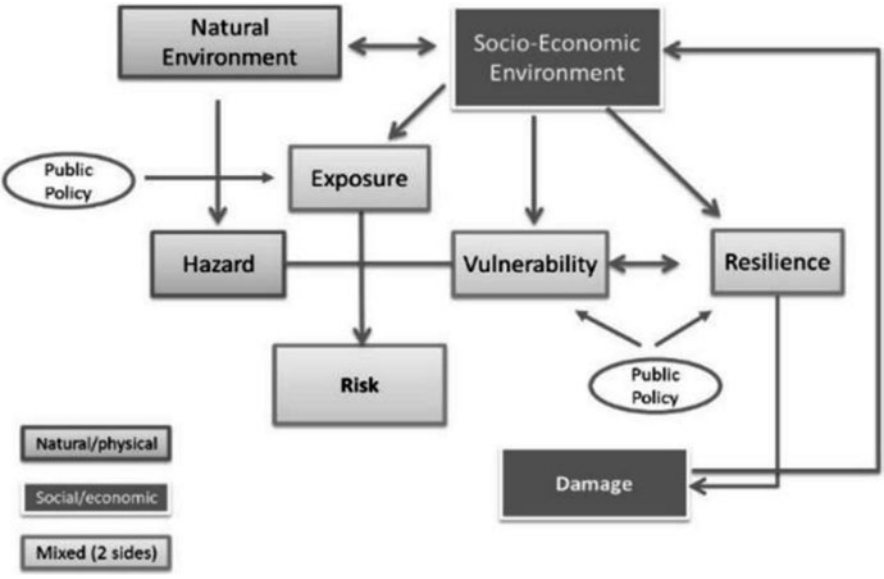

Fig. 3.2 Socio-ecological framework for extreme events, our interpretation of Modica and Zoboli (2016)

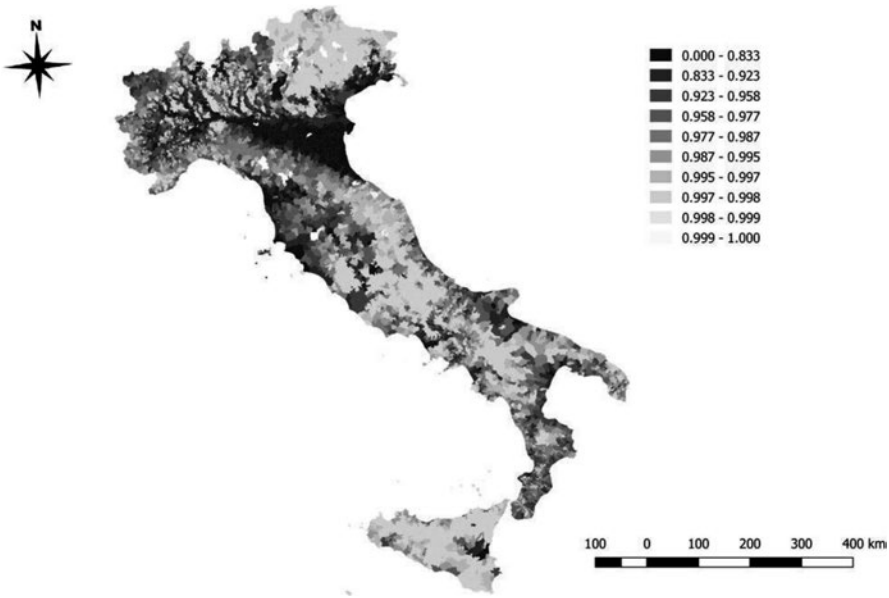

Fig. 3.3 Hydrological hazard at municipal level. Source: ISTAT

information. For natural hazards, public institutions generally provide risk maps. When looking at exposure several proxies can be used in order to include this relevant feature in the analysis. Marin and Modica (2017) provided several exposure indicators starting from the analysis of public data. Common proxies are local: population; employment; per capita income; number of buildings; housing values; agricultural variables; and so on. Finally, vulnerability and resilience can be seen as composite indicators that address several aspects of the socio-economic conditions of selected areas. Based on the work of Modica, Reggiani, and Nijkamp (2019), a systematic review of the indicators of vulnerability and resilience is provided. Marin et al. (2019) built the composite indicators of vulnerability and resilience using 17 variables for the vulnerability index and 13 for the resilience index. As an example, Figure 3.3 shows the hydrogeological risk for Italy aggregated in order to show the municipalities that are at risk of floods, according to the different degrees of probability of hazard occurrence. The data are scaled between 0 and 1.

5 Framework for Recovery and Development Paths

Communicative as it is, the concept of resilience does not indicate a condition or a status that a community needs to reach to be considered so. Resilience indicates the dynamic process of a community facing the consequences of an exogenous or endogenous shock. Therefore, it is not easy to indicate one single measure of

resilience. In this paragraph, as in the framework we propose, we will argue that a single measure for resilience is not required.

Most of the attention that the concept of resilience gained in the last decades is due to the concept's linking ability between the academic field and the reality of actions and policies interventions. This communicative and connecting power of the concept is at the bedrock of our framework. Indeed, in our framework, the concept of resilience is tightly interwoven with both the context on which is applied and the shock which affected it. Different shocks can affect communities and regions in very different ways, requiring different strategies to evaluate and reduce risks.

Moving onward from the seminal contribution of Barca et al. (2012), it should be argued that not only development (and recovery) strategies should be differentiated by the characteristics of different places and different communities, but the heuristic measurement of resilience itself should be differentiated. Place-based strategies (Barca et al., 2012; Lucatelli, Carlucci, & Guerrizio, 2014) proved to be very effective by capturing the specificities of communities instead of focusing on general propositions and solutions. Similarly, the framework that we present, exploits the dynamic nature of the concept of resilience to put communities at the center and allowing for different heuristic measures of resilience.

Indeed, such place-based perspective not only requires the different recovery and development strategies for different places and communities, it also requires the resilience to be heuristically measured on the best-suited characteristics able to capture its dynamic variation for different communities and places.

Holding such a place-based, community-centered, perspective at its core, it is impossible to propose generalized indications and strategies on how to build such resilient communities, connecting recovery and development paths. Even considering, as is common in literature, a differentiation based on typologies (such as urban-rural, industrialized-service oriented, traditionalist-progressive, etc.), we would not be taking into account the specificities produced by their particular geography and history.

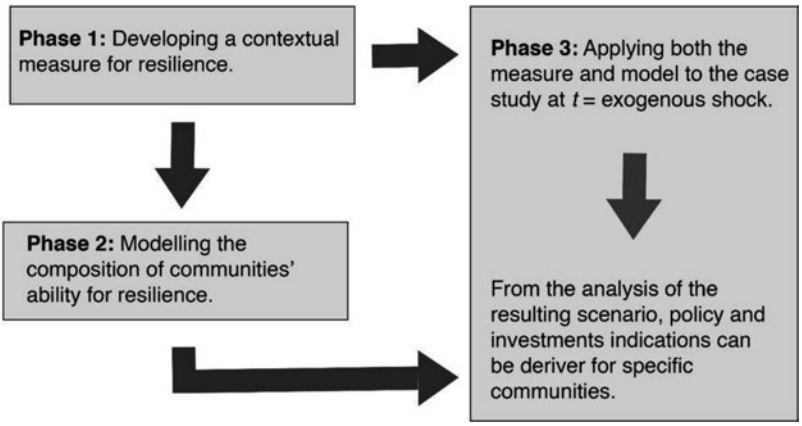

Fig. 3.4 Phases of resilience context-bound framework

Thus considered, the following *Context-Bound Framework for Resilience* is an attempt to deal with such complexity while proposing a generalizable and unified strategy to build resilient communities.

5.1 Context-Bound Framework for Resilience

Taking the field from this place-based perspective, a Context-Bound Framework for Resilience is proposed, connecting recovery and development paths. Considered that in this community-centered perspective, each community or region is potentially unique it is important to allow for generic solutions and policy indications. In this way, the proposed framework is not only a "framework for action" but also a "framework for research," which does not contain policies indications but is designed to extract them from the field.

The framework aims to be highly specific in its results and, at the same time, be completely generalizable in its research design. Performing such a task means to develop a research design rigorous enough to be generalized but also very flexible to be applicable in many different contexts. The framework assumes that resilience, as an evolutionary ability to deal and adapt after an exogenous shock, is composed differently according to different characteristics and historical and geographical processes involving the community. To account for this, the research design is divided into three phases as follows.

The first phase is developing a measure of resilience. This measure is different for different contexts and involves the relevant socio-economic processes affecting the communities. This dynamic measure for resilience is used as a thermometer, alone it does not tell how the resilience ability is composed, it only is a measure of the health of a community over time and it is used to indicate which communities are healthier and which aren't.

The second phase is the most delicate, it involves the modelling how this ability is composed. It is assumed that the ability for resilience can be composed very differently for different contexts, thus implying that we refuse any specific assumption about how this ability is composed. This choice for a context-bound framework imposes us to explore a wide range of factors and characteristics of communities (contrary to a top-down model where the composition of resilience is defined a-priori over a close set of characteristics). A specific model for the resilience ability is developed from this wide range of features for the interested communities. As we will show with an example, it is proposed to employ Machine Learning solution to the problem about how to develop a model for resilience. In phase one, a dynamic measure for resilience is developed; Machine Learning tools (due to their statistical computational ability) allow us to use the said measure, alongside a wide range of characteristics, to fit a model tailored on the interested context. In the best-case scenario—as in the example below—the model is trained (fitted) over the same or similar context (e.g., in the same area, affected by the same socio-economic processes) affected by the comparable shocks in the recent past. The selection of such

context on which to fit the model is extremely important and might sometime represent a big challenge to overcome.

In phase three, the developed model is applied to the case study at the time of the exogenous shock, producing a scenario of how the affected communities will be resilient or not. The specific results in the scenario, coupled with the analysis of the model behind it, allow us to derive specific policy directions and indications to improve communities' chances to be resilient.

This simple and very flexible research strategy can be applied to very different cases since the specific results (phase three) depend from how the researcher defines and models the ability for resilience (phases one and two). While both the strategy and methodology applied stay the same, the decisions about how to measure and model resilience need to be tailored by the researcher on the context.

Fantechi and Modica (2020) provided an example of how such a context-bound framework is employed in real case studies.

Problem Definition The research is preoccupied with developing a model of community resilience[7] for the vastly rural area affected by the "Summer 2016 Central Italy" earthquake (Gruppo di Lavoro INGV, 2016). Alongside seismic activity the same area, like most rural areas of the inner part of the country, is also affected by decades-long processes of depopulation, aging and most of its communities fail to keep pace with the contemporary economic structure. How do you model the resilience ability of such communities? Literature on disaster resilience, mostly focused on urban and industrial contexts, mostly consider such areas only in comparison with other contexts (e.g., urban vs rural). As shown in a rigorous comparative study, applying a Resilience Index such as the DROP Model (Cutter, Ash, & Emrich, 2016) indicates that rural areas have a different composition of the ability for resilience. According to this study, the rural areas score the highest points in the social capital component of the index, while scoring the lowest in the economic and institutional components. Comparative studies like this clearly show that the resilience ability is differently composed in different areas, at the same time we would be wrong assuming that, to build better resilient communities, we should target the social capital component.

Phase One In the attempt to develop the specific indications on how to build better resilient communities, for the rural area of Central Italy, Fantechi and Modica (2020) explore the socio-economic processes involving the area. The major problem of this rural part of the area is the decade-old progressive process of depopulation involving the whole area (Lucatelli et al., 2014). As shown in Fantechi et al. (2020) using yearly population variation it is possible to model resilience dynamics across

[7] In the research provided as example of application of the presented *context-bound framework for resilience* communities are proxied at the smallest administrative level for which data are consistently available, the municipality. For a specific discussion on the availability of data and on the reliability of municipal administrative boundaries as good proxies for rural communities for the Italian context, please refer to Fantechi et al. (2020).

an exogenous shock. Specifically, they used the mean yearly population variation over five-year periods before and after the earthquake, classifying as "successfully resilient" those communities which in the 5 years after the extreme events achieve a higher mean rate of population variation compared to the 5 years before. All other communities were classified as "unsuccessfully resilient."

Phase Two Fantechi and Modica (2020) employed a Classification Machine Learning solution for the modelling of resilience ability. A classification solution means that they aim at training an algorithm to discriminate (classify) cases among two or more defined classes. Specifically, in this study, the algorithm is trained to classify among two classes "successfully resilient" and "unsuccessfully resilient"—employing the cases from the recent past for the training of the algorithm. Cases affected from three similar seismic events in the recent past (specifically communities affected by the 1997 Umbria and Marche earthquake, the 2009 L'Aquila earthquake, and the 2012 Emilia earthquake) were considered as candidates for the training of the algorithm. After a thorough evaluation of the three events, and more extensively the different contexts affected by such events, only communities affected by two of the three events (1997 Umbria and Marche earthquake and 2009 L'Aquila earthquake, for a total of 135 observations) were selected for the training of the algorithm. As mentioned above, the selection of such cases is extremely important for the reliability of results and should be performed to ensure the maximum comparability of contexts and socio-economic processes involving the communities.

Literature in community disaster resilience (Aldrich & Meyer, 2014; Birkmann, 2007; Cutter et al., 2008; Mayunga, 2007; Morrow, 2008) indicates that the ability for resilience is composed of a wide range of features describing different spheres of the community's life. Starting from this differentiated literature and purposely avoiding assuming resilience ability to be composed by one set or another for our context, authors gathered data for a wide set of over 40 features and the final model is a specific logistic classification model for rural communities of Central Italy of their resilience ability with an accuracy of 85%.

Phase Three Finally, the model is applied to the communities affected by the "Summer 2016 Central Italy" earthquake. The resulting scenario, coupled with the analysis of the model behind them, can be easily translated into practical policy directions for the communities affected by the earthquake. The scenario developed by Fantechi and Modica (2020) provides the indications about which communities already have the right set of characteristics to be able to successfully recover and which communities need the institutional interventions and investments to avoid falling behind even more. The analysis of such scenario, coupled with the analysis of the model on which is constructed, provides not only indications of which communities are more in need of institutional interventions, but also provide information to design specific and tailored policies for those community.

In conclusion, it can be said that the strength of such design is that the three steps procedure described above allows policy makers, practitioners, and researchers to

assess the resilience ability of communities right at the moment of the exogenous shock and delineate a specific profile of the resilient communities. Furthermore, local policy and investments indications can be provided ex-ante, allowing policy makers to immediately outline strategies to improve the ability of community resilience of the territories under investigation, impacting both the reconstruction process and the development path.

The example discussed above (Fantechi & Modica, 2020) is a first attempt to put such context-bound framework for resilience into action employing real data, thus still partially suffering from the relatively small sample on which the algorithm is trained. However, the model presented above is based on sound literature and already able to make accurate predictions. This, coupled with the constant improving of data production and collection, suggests that the employed data-oriented strategy in the application of the proposed *Context-bound Framework for Resilience* is a reliable option, an option which can easily provide a specific ex-ante information to outline the local policies impacting both the reconstruction process and the development path of communities.

6 Summary and Conclusions

Natural phenomena with the intensity and characteristics to trigger a socio-natural disaster are more frequent than ever. These phenomena remain mostly unpredictable and unpreventable with today's technology. Dealing with such reality, as a society, means that we have to shape our social and built environment to reduce the chances of a natural phenomenon to turn into a socio-natural disaster. Even so, the occurrence of disasters triggered by natural phenomenon is not eliminable in the foreseeable future, meaning that we also have to equip communities—especially the most vulnerable ones—to cope with such events and exploit every opportunity to stir them into more comfortable development paths.

In this chapter, the *Context-Bound Framework for Resilience has been* proposed and presented which is composed of generalizable research and design strategy and aims at producing highly context-specific results. Through the lenses of community resilience, the chapter argued for the coordinated strategies and policies focusing on communities, the dynamic processes involving them, their needs and specific characteristics. Major characteristic of this framework is that it inherently interconnects the recovery process to the community's development path. Such interconnection is built upon the idea that exogenous shocks produce a window of opportunity—by suspending the everyday life of the affected communities—which can be exploited through tailored actions and investments.

Being a resilient community means to be adjustable and adaptive. Addressing the issue of building more resilient communities with the proposed framework means addressing socio-economic processes and issues involving the community,

equipping them with the improved abilities to cope with the disaster but also to impact positively their development paths.

An important element of nuance is the proposed use of modern computation tools. Employing such tools not only allows to design standardized strategies for very different contexts, but it also allows various degrees of flexibility. Indeed, varying the level of analysis (e.g., from *neighborhoods, to municipalities, to regions*), the research design can be maintained while producing more generalizable results. Indeed, while both the research strategy and the aims remain the same, there is a trade-off between the specificity of the results and their generalizability out of the specific context.

The digital revolution of the last decade already impacted how we think and plan for the world. Every day, the computational capacity at our hands improves as well as the possibilities for data creation and data collection. Following these trends, the future improvement and iterations of this work will focus on exploiting these computational tools to provide more generalizable results while still maintaining a granular level of analysis.

References

Aitsi-Selmi, A., Egawa, S., Sasaki, H., Wannous, C., & Murray, V. (2015). The Sendai framework for disaster risk reduction: Renewing the global commitment to people's resilience, health, and well-being. *International Journal of Disaster Risk Science, 6*(2), 164–176.

Aldrich, D. P., & Meyer, M. A. (2014). Social capital and community resilience. *The American Behavioral Scientist, 59*, 1–16.

Barca, F., McCann, P., & Rodriguez-Pose, A. (2012). The case for regional development intervention: Place-based versus place-neutral approaches. *Journal of Regional Science, 52*(1), 134–152.

Belmonte, A., Bove, V., D'Inverno, G., & Modica, M. (2019). School infrastructure spending and educational outcomes: Evidence from the 2012 earthquake in Northern Italy. *Economics of Education Review, 2019*, 101951.

Below, R., & Wallemacq, P. (2018). *Annual disaster statistical review 2017*. Centre for Research on the Epidemiology of Disasters (CRED).

Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. Doubleday & Company.

Birkmann, J. (2007). Risk and vulnerability indicators at different scales: Applicability, usefulness and policy implications. *Environmental Hazards, 7*(1), 20–31.

Bodin, P., & Wiman, B. (2004). Resilience and other stability concepts in ecology: Notes on their origin, validity, and usefulness. *ESS Bulletin, 2*(2), 33–43.

Boschma, R. (2015). Towards an evolutionary perspective on regional resilience. *Regional Studies, 49*, 733–751.

Boschma, R. A., & Martin, R. (2010). *The handbook of evolutionary economic geography*. Edward Elgar.

Cardona, O. D. (2011). Disaster risk and vulnerability: Notions and measurement of human and environmental insecurity. In H. G. Brauch, U. Oswald Spring, C. Mesjasz, J. Grin, P. Kameri-Mbote, B. Chourou, P. Dunay, & J. Birkmann (Eds.), *Coping with global environmental change, disasters and security – Threats, challenges, vulnerabilities and risks* (pp. 107–122). Springer Verlag.

Cardona, O. D., van Aalst, M. K., Birkmann, J., Fordham, M., McGregor, G., Perez, R., Pulwarty, R. S., Schipper, E. L. F., & Sinh, B. T. (2012). Determinants of risk: Exposure and vulnerability. In C. B. Field, 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, & P. M. Midgley (Eds.), *Managing the risks of extreme events and disasters to advance climate change adaptation* (pp. 65–108). Cambridge University Press.

Carpenter, A. (2015). Resilience in the social and physical realms: Lessons from the Gulf Coast. *International Journal of Disaster Risk Reduction, 14*, 290–301.

Carpenter, S., Walker, B., Anderies, J. M., & Abel, N. (2001). From metaphor to measurement: Resilience of what to what? *Ecosystems, 4*(8), 765–781.

Christopherson, S., Michie, J., & Tyler, P. (2010). Regional resilience: Theoretical and empirical perspectives. *Cambridge Journal of Regions, Economy and Society, 3*(1), 3–10.

Corbo, L., Corrado, R., & Ferriani, S. (2016). A new order of things: Network mechanisms of field evolution in the aftermath of an exogenous shock. *Organization Studies, 37*(3), 323–348.

Cutter, S. L., Ash, K. D., & Emrich, C. T. (2016). Urban–rural differences in disaster resilience. *Annals of the American Association of Geographers, 106*(6), 1236–1252.

Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change, 18*, 598–606.

Devitofrancesco, A., Ghellere, M., Meroni, I., Modica, M., Paleari, S., & Zoboli, R. (2016). Sustainability assessment of urban areas through a multicriteria decision support system. In *CESB 2016 conference* (pp. 499–506). Grada Publishing.

Faggian, A., Gemmiti, R., Jaquet, T., & Santini, I. (2018). Regional economic resilience: The experience of the Italian local labor systems. *The Annals of Regional Science, 60*(2), 393–410.

Fantechi, F., & Modica, M. (2020*). Learning from the past. Forecasting community disaster resilience after the 2016 central Italy earthquake via supervised machine learning (mimeo)*. https://www.aisre.it/2014-07-04-13-37-28/archivio-abstracts?start=60

Fantechi, F., Urso, G., & Modica, M. (2020). Can extreme events be an opportunity? Depopulation and resilience of rural communities in central Italy after the 1997 earthquake. *Journal of Rural Studies, 79*, 311–321.

Gruppo di Lavoro, INGV. (2016). *Primo rapporto di sintesi sul terremoto di amatrice ml 6.0 del 24 agosto 2016 Iitalia centrale*. http://hdl.handle.net/2122/11157

Guidoboni, E., & Valensise, G. (2013). Istituto nazionale di geofisica (Italia). In E. Guidoboni & G. Valensise (Eds.), *L'Italia dei disastri: dati e riflessioni sull'impatto degli eventi naturali* (pp. 1861–2013). Bononia University Press.

Hoffmann, A. A., & Hercus, M. J. (2000). Environmental stress as an evolutionary force. *Bioscience, 50*(3), 217–226.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics, 4*(1), 1–23.

Thornton, P. H. (2002). The rise of the corporation in a craft industry: Conflict and conformity in institutional logics. *Academy of Management Journal, 45*(1), 81–101.

Iovino, L., D'Emidio, M., & Modica, M. (2020). Creating an holistic emergency alert management platform. *Journal of Urban Technology, 27*(2), 3–20.

LaFontaine, J. H., Hart, R. M., Hay, L. E., Farmer, W. H., Bock, A. R., Viger, R. J., Markstrom, S. L., Regan, R. S., & Driscoll, J. M. (2019). *Simulation of water availability in the Southeastern United States for historical and potential future climate and land-cover conditions: U.S. Geological Survey Scientific Investigations Report 2019–5039* (p. 83).

Lucatelli, S., Carlucci, C., & Guerrizio, A. (2014). A strategy for 'inner areas' in Italy. In *Education, local economy and job opportunities in rural areas in the context of demographic change: Proceedings of the 2. EURUFU Scientific Conference* (pp. 69–79).

Marin, G., & Modica, M. (2017). Socio-economic exposure to natural disasters. *Environmental Impact Assessment Review, 64*, 57–66.

Marin, G., Modica, M., Paleari, S., & Zoboli, R. (2019). *Disaster risk management: Building the 'disaster risk assessment tool' for Italy*. Sustainability Environmental Economics and Dynamics Studies (SEEDS).

Martin, R. (2011). Regional economic resilience, hysteresis and recessionary shocks. *Journal of Economic Geography, 12*(1), 1–32.

Martin, R., & Sunley, P. (2006). Path dependence and regional economic evolution. Papers in evolutionary economic geography (PEEG), Group Economic Geography, Department of Human Geography and Spatial Planning, Utrecht University, revised Mar 2006. Handle: RePEc:egu:wpaper:0606.

Mayunga, J. S. (2007). Understanding and applying the concept of community disaster resilience: A capital-based approach. *Summer Academy for Social Vulnerability and Resilience Building, 1*(1), 1–16.

Mela, A., Mugnano, S., & Olori, D. (2017). *Territori vulnerabili: verso una nuova sociologia dei disastri Italiana*. FrancoAngeli.

Miller, F., Osbahr, H., Boyd, E., Thomalla, F., Bharwani, S., Ziervogel, G., & Nelson, D. (2010). Resilience and vulnerability: Complementary or conflicting concepts? *Ecology and Society, 15*(3), 11.

Modica, M., Faggian, A., & Aloisio, R. (2019). The post-earthquake reconstruction in L'Aquila: Some reflections. *Scienze Regionali, 18*, 515–522.

Modica, M., & Reggiani, A. (2015). Spatial economic resilience: Overview and perspectives. *Networks and Spatial Economics, 15*(2), 211–233.

Modica, M., Reggiani, A., & Nijkamp, P. (2017). Methodological advances in Gibrat's and Zipf's laws: A comparative empirical study on the evolution of urban systems. In *Socioeconomic environmental policies and evaluations in regional science* (pp. 37–59). Springer.

Modica, M., Reggiani, A., & Nijkamp, P. (2019). Vulnerability, resilience and exposure: Methodological aspects. In *Advances in spatial and economic modeling of disaster impacts* (pp. 295–324). Springer.

Modica, M., & Zoboli, R. (2016). Vulnerability, resilience, hazard, risk, damage, and loss: a socio-ecological framework for natural disaster analysis. *Web Ecology, 16*(1), 59–62.

Morrow, B. H. (2008). *Community resilience: A social justice perspective* (Vol. 4). Community and Regional Resilience Institute.

Naheed, S., & Eslamian, S. (2021). Understanding disaster risk reduction and resilience: A conceptual framework, Ch. 1. In S. Eslamian & F. Eslamian (Eds.), *Handbook of disaster risk reduction for resilience: New frameworks for building resilience to disasters* (pp. 1–25). Springer.

NAP. (2016). *Attribution of extreme weather events in the context of climate change*. National Academies Press.

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology, 41*(1-2), 127–150.

OECD. (2013). *Policy making after disasters: Helping regions become resilient–the case of post-earthquake Abruzzo*. Organisation for Economic Co-operation and Development.

Powell, W., White, D. R., Koput, K., & Owen-Smith, J. (2005). Network dynamics and field evolution: The growth of interorganizational collaboration in the life sciences. *American Journal of Sociology, 110*(4), 1132–1205.

Simmie, J., & Martin, R. (2010). The economic resilience of regions: Towards an evolutionary approach. *Cambridge Journal of Regions, Economy and Society, 3*, 27–43.

Sine, W. D., & David, R. J. (2003). Environmental jolts, institutional change, and the creation of entrepreneurial opportunity in the US electric power industry. *Research Policy, 32*(2), 185–207.

Stott, P. (2016). How climate change affects extreme weather events. *Science, 352*(6293), 1517–1518.

Turner, J. H., & Maryanski, A. (2013). *The evolution of the neurological basis of human sociality* (pp. 289–309). Springer.

Ummenhofer, C. C., & Meehl, G. A. (2017). Extreme weather and climate events with ecological relevance: A review. *Philosophical Transactions of the Royal Society, B: Biological Sciences, 372*(1723), 20160135.

UNDRO. (1980). *Natural disasters and vulnerability analysis*. UNDRO.

UNISDR. (2005). Hyogo framework for action 2005-2015: Building the resilience of nations and communities to disasters. In *Extract from the final report of the world conference on disaster reduction (A/CONF. 206/6)* (Vol. 380). The United Nations International Strategy for Disaster Reduction.

UNISDR. (2011). *Global assessment report on disaster risk reduction: Revealing risk, redefining development*. United Nations International Strategy for Disaster Reduction.

Wilson, G. A. (2014). Community resilience: Path dependency, lock-in effects and transitional ruptures. *Journal of Environmental Planning and Management, 57*(1), 1–26.