



## ENSURE PROJECT

Contract n° 212045

# ENSURE E-LERNING TOOL

## F21

### **Relationships among vulnerabilities and resilience: an assessment perspective**



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#### **Reference reports:**

Del. 2.2: Integration of different vulnerabilities vs. Natural and Na-tech Hazards (chap 6.3 and 6.4)




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# 1 Relationships among vulnerabilities and resilience

The relationship vulnerability/resilience represents a key question within the Ensure Project. The latter indeed is aimed to integrate different perspectives of vulnerability in order to enhance resilience: such a goal clearly requires to clarify how the two concepts influence or interact with each other.

Both the concepts (vulnerability and resilience) and their relationships are largely debated within scientific community and finding out some shared ideas in order to drive future approaches is not an easy task. As broadly mentioned, at present, a sort of “Babylonian confusion” characterizes not only the concepts of vulnerability, resilience but even some other relevant terms in the disaster field (coping capacity, adaptability,...). As underlined in the previous chapter, the idea that vulnerability and resilience are two overlapping concepts or more precisely that vulnerability represents the “flip-side” of resilience and vice versa is largely disproved by many scholars and above all by the case-studies. According to the flip-side approach, “high levels of vulnerability imply a low resilience, and vice versa” (Cannon, 2008): most of the case studies highlight, on the opposite, that a system can show high levels of physical vulnerability with respect to the impact of a hazard and, in the meanwhile, high level of resilience mainly referred to the capacity of recovering after the event or, even, low levels both of vulnerability and resilience. Moreover, as mitigation measures aimed at reducing some aspects of vulnerability can result in an increase of others, in the same manner, measures addressed to reduce some aspect of vulnerability do not necessarily achieve an increase of resilience and measures addressed to enhance resilience do not necessary reduce vulnerability.

Hence, it is possible to state that as the relationships among different facets of vulnerability and different dimensions of resilience can be ambiguous, the relationship between vulnerability and resilience cannot be reduced to a flip-side one.

On the contrary, the idea that the two concepts are separate, even though linked, is largely shared and supported by several case studies. Nevertheless, even according to such a position many different points of view and some open questions are at stake.

Some scholars highlight that vulnerability and resilience have to be interpreted as independent factors or processes, both of them acting in different phases of the disaster cycle, at different levels (individual, communities...) and contributing respectively to losses and adaptation (Paton, 2008). Other scholars underline that these concepts are partially overlapping: hence, “they are not totally mutually exclusive, nor totally mutually inclusive” (Cutter et al., 2008). By this perspective, adaptive capacity plays a core role in that it determines the distinction between the inclusive and the separate position, both related to the “no flip-side” interpretation. Furthermore, up to now some attempts for identifying and measuring (in quantitative or qualitative terms) the main factors influencing or determining the different aspect of vulnerability have been carried out – even though an integrated approach to all these aspects is still missing. On the opposite, the studies focused on resilience, since the latter has gain prominence in the disaster field only recently, are less numerous than the ones on vulnerability and very few among them include methods for quantifying resilience. Moreover, it is still so unclear which are the main factors affecting resilience or even which are its main

components and which variables or indicators have to be taken into account in order to measure such components so that Rose (2007) stated that “resilience is in danger of becoming a vacuous buzzword from overuse and ambiguity”.

Based on these premises and according to the review provided in the present and previous WPs on vulnerability and resilience, we will try to draw out some first ideas on this crucial topic for the Ensure project.

#### ✦ ***Vulnerability and Resilience are multifaceted concepts***

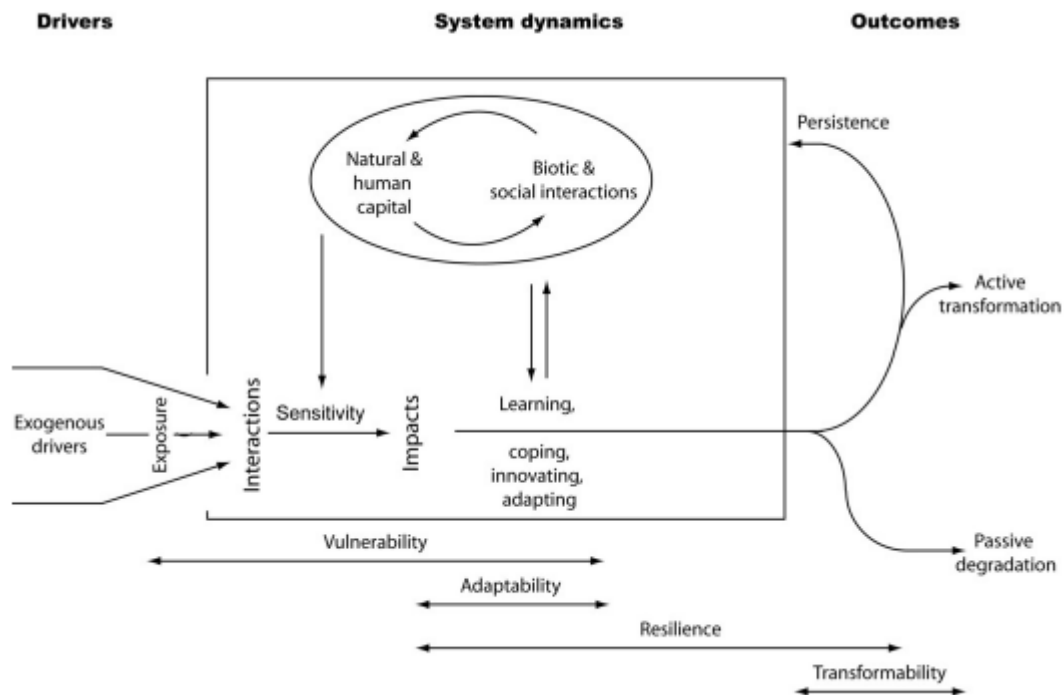
It has been largely highlighted that vulnerability and resilience are multifaceted concepts. Moreover, the different facets of vulnerability and the mutual relationships among them and the different dimensions of resilience and their relationships have been defined.

#### ✦ ***Vulnerability and Resilience are separate concepts, partially overlapping***

A shared idea rising from the tasks of WP2 is that vulnerability has to be referred both to the susceptibility to losses and to the capacity to recover. In the meanwhile, one of the most recent definition of resilience refers to “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” (UN/ISDR, 2009). Therefore, recognizing that these concepts partially overlap, it is worth stressing that within the overlapping area both the robustness of elements and systems and their coping capacity, largely interpreted as a part of vulnerability as well as of the resilience one, have to be included. Some scholars identify adaptability as the overlapping part between resilience and vulnerability. Clearly, coping capacity and adaptability are closely linked, even though the latter cannot be interpreted only as a part of the coping: it is indeed closely related to learning, which is recognized as a premise for adaptability (Folke et al., 2002), and implies a flexibility to change (Godshalk, 2003) which is not necessarily included in the concept of coping. Moreover, stressing on the aspects of vulnerability and resilience which do not overlap, it is worth mentioning that resilience includes both the ability to restore previous conditions and the ability to adapt to (or to create) new conditions (physical, social, economic....). By this perspective, innovation is part of the resilience concept but not of the vulnerability one (fig. 1).

Summing up, whilst vulnerabilities refer to the susceptibility to be damaged of elements or systems, taking into account the capacity of individuals, communities or institutions to cope with the impact of a given event, avoiding further losses and guaranteeing the “bouncing back” of the hit area to a previous state, resilience includes dimensions as robustness, which can be interpreted as the flip-side of vulnerability, but also as adaptability or transformability which represent the capacity of elements and systems to adapt or transform themselves after the impact of an event. According to this, elements and systems may be vulnerable to a given event and, in the meanwhile, they can be resilient in that they can transform the disaster in a “window of opportunity” for changing.

Figure 1: Integrate vulnerability, adaptability and resilience (Chapin, 2009)



✦ ***Vulnerability and Resilience are dynamic concepts related to the different phases of the disaster cycle***

Some scholars identify vulnerability as the static and resilience as the dynamic propensity of a system in relation to a threat. Nevertheless, it has already been stressed that the different aspects of vulnerability emerge at different scales and at different phases of the disaster cycle, from the pre-disaster to the reconstruction phase. Hence, time is a key factor in analyzing vulnerabilities. With respect to resilience, different dimensions (robustness, adaptability, etc) come on stage in different phases of the disaster cycle and it has already been stressed that most of the identified dimensions of resilience (e.g. learning capacity, rapidity, ...) are largely time-related.

Summing up, both concepts refer to features and behaviors of coupled human-natural systems that change over time and space, both due to endogenous factors and to external stress factors. Hence, both vulnerability and resilience have to be interpreted as dynamic concepts.

✦ ***Vulnerability and Resilience have mutual influences***

As already mentioned, vulnerability and resilience have mutual influences. In detail, Resilience may have a relevant role during emergency, relief and recovery periods in facilitating "vulnerability transfer and redistribution among actors, communities, territories" (del. 2.1.3 pr. 8.1) or in producing new vulnerabilities. Moreover, some examples of changes (generally due to the implementation of specific mitigation measures) of vulnerability features which induced negative effects on some key dimensions of resilience have been provided. Hence, the change of the different aspects

of vulnerability over time has to be investigated taking into account the mutual influences among vulnerabilities and the key dimensions of resilience.

⇒ ***Vulnerability and Resilience: “lenses” for understanding the complex behaviors of territorial systems exposed to a threat***

The two concepts, as well as their facets or dimensions, can be interpreted as two different “lenses” or conceptual categories for analyzing how a complex system, namely a territory in all its aspects, reacts to an hazardous event. Obviously, the behavior of a complex systems hit by an external stress depends on many factors: some of them can be categorized and analyzed under the lens of the vulnerability, others under the one of resilience.

In detail, the lens of vulnerability is more focused on the features of elements or systems allowing them to resist to the impact of a given event, in terms both of not being damaged and of reducing losses through an effective management of emergency phase (conservative approach). The lens of resilience is more focused on the features of elements or systems allowing them, even though hit and damaged by a hazardous event, to adapt or change according to new conditions, modifying and sometimes improving their previous state (adaptive approach).

⇒ ***Vulnerability and Resilience assessment***

According to the provided interpretation of the two mentioned concepts, it is worth noting that whilst in the field of vulnerability analysis many steps toward an effective assessment of the different facets have been done, even though an integrated assessment of vulnerabilities is still lacking, methods and tools for an effective Resilience assessment are still at an early stage.

Since resilience has gain prominence in the disaster field only recently, available studies are still largely focused on theoretical aspects (which are the main factors affecting resilience or even which are its main components). The few researches addressed to provide methods and tools to measure resilience seems to be still largely focused on the idea that resilience represents the ability of a system to bounce back or to restore a previous state of the system itself or, in other words, on the idea of resilience as a flip-side of vulnerability. Therefore, starting from the definition of the key-dimensions of resilience and their relationships, a further step toward the definition of adequate qualitative or quantitative indicators for an effective assessment of resilience is required.

## 2 Basic principles for integrating vulnerabilities to natural and na-tech events

Many hints arise from the work developed in WP1 and WP2: many questions have been faced, a common background on the main topic related to vulnerability analysis has been set up; the concept of resilience has been deepened; the relationships among the different facets of vulnerability have been investigated; the key dimensions of resilience have been identified; the dynamic feature both of vulnerability and resilience, the mutual influences between them and the key role of some factors (e.g. land use planning policies, mitigation measures or even resilience itself) in changing vulnerabilities over time or in space, through mechanism of transfer and redistribution among actors, communities, territories have been highlighted.

Summing up, some relevant steps forwards along the path for integrating the different facets or the different perspectives of vulnerability in order to enhance the resilience of communities and territories have been taken, even though many questions are still open. According to the Dow of the Ensure project, the development of a new methodological framework for an Integrated Vulnerability Assessment represents the main objective of the WP4. Therefore, this paragraph, grounding on the achieved results, provides some general principles for building up such a methodological framework. These principles provide a first answer to the many questions raised along the research path developed up to now, open the floor to other questions to be developed in the WP3 and represent the key points which cannot be missed for renewing the field of vulnerability assessment in terms of approaches, methods and tools.

### **Which aims for an integrated vulnerability assessment?**

First of all, it is worth stressing that an integrated assessment of vulnerabilities can be addressed to different aims. For example, it can be carried out to support land use planning choices or civil protection strategies or even economic or social policies at different scales (local, regional, national...). Therefore, the specific aims of these policies and the different scales they refer to require different types of analysis at different scales with different focuses. Hence, the methodological framework would provide a general path in which flexible procedures and indicators have to be specified according to different aims, contexts and scales.

### **Vulnerability as a “whole”**

Largely shared by partners is the idea that vulnerability represents a 'whole' characterized by numerous facets characterized by close relationships. Hence, the methodological framework has to be based on a holistic approach in that each aspect has to be analyzed taking into account the multiple relationships between such aspect and all the others.

### **Qualitative or quantitative assessment?**

In previous tasks some practical attempts to integrate some of the many facets of vulnerability or resilience through numerical indexes have been provided. These studies, based on quantitative approaches, often drive towards simplified and aggregate numerical indexes, neglecting aspects of vulnerability and resilience which, even though difficult to quantify, are



relevant to a fully understanding of complex systems (e.g. territorial and social ones) behaviour, hit by an external stress. Moreover, aggregate indexes, which are very useful to rank different territories according to their vulnerability or to support choices related to resource allocation, have to be coupled with disaggregate information in order to effectively drive policies aimed at reducing vulnerabilities and/or enhancing resilience.

Therefore, vulnerability assessment has to be based on a coupled qualitative and quantitative approach in order to provide a variety of inputs flexible to different aims and able to support different policies.

### **A shift in thinking in hazard assessment for an effective integrated assessment of vulnerabilities**

Taking into account the many facets of vulnerability with respect to an individual hazard is already a relevant step towards an integrated vulnerability assessment. Nevertheless, hazards are changing, shifting from an individual form towards “an interactive mix of natural, technological and social events” (Mitchell, 1999). As a consequence, the still widespread reductionist approach to hazard analysis drives us to underestimate potential chains and synergies among such events and, consequently, to neglect relevant aspects in vulnerability assessment.

Therefore, an effective integrated assessment of vulnerability requires first of all a shift in thinking in the field of hazard analysis: besides the understanding of the different hazards which potentially threaten a given territory, the evolution paths of such hazards including the potential synergies and chains among them have to be in depth investigated.

### **Assessing vulnerability taking into account its dynamic feature**

Vulnerability cannot be interpreted as a static concept: all facets of the vulnerability and the relationships among them change over time due to external factors and to mutual influences among them and among vulnerabilities and reliance dimensions.

Therefore, an effective vulnerability assessment has to be based on a constantly updated knowledge of the different facets of vulnerabilities and on the many factors which can contribute to induce, modify and transfer vulnerabilities over time. In other words, vulnerability assessment has to be structured as a “continuous cycle”, in which the preventive assessment of the potential outcomes of mitigation measures – in terms of effects on vulnerability and resilience – and the monitoring of the effects due to their implementation have to be included. As previously stated (see § 5), measures aimed at preventing hazards or at reducing some aspect of vulnerability or even at enhancing some dimensions of resilience do not necessarily result in a reduction of risk, driving sometimes towards an increase of other aspects of vulnerability or a decrease of resilience.

### **Assessing vulnerability along the stages of the disaster cycle**

This principle is closely linked to the previous one; indeed, vulnerabilities and their relationships change over time and mainly, as stressed before, over the different stages of the disaster cycles, according to the evolution paths of the hazards, to the mutual influences among the different facets of vulnerability, to the interventions set up at different stages of the disaster cycle. Some facets of vulnerability are very relevant in some stages of the disaster cycles but

they can be neglected in others: for examples, some facets do not appear at early stage whereas they can become more and more relevant in long term and vice-versa.

Therefore, along the “continuous cycle” of the vulnerability assessment, the changes affecting each facet of vulnerability and their mutual relationships over the different stages of the disaster cycle have to be taken into account.

### **Space and time factors in assessing vulnerabilities**

Territorial systems change dynamically over time. Moreover, as well as vulnerabilities are linked to each other, different territories will have many connections and mutual relationships with the surrounding ones. Small and fast changes are likely to take place at the small-scale level whereas changes at the large-scale level are likely to be larger and slower reverberating on a local scale. According to such changes vulnerabilities and the mutual linkages among them may change, propagate or transfer over time from one territory to another one.

Therefore, vulnerability assessment has to look beyond the area under investigation, taking into account the relationships among the investigated area and the wider regions that it belongs to and their changes over time.

### **Multi-scale and cross-scale analyses**

Some factors influencing vulnerabilities at local scale may be understood at large scale and not be recognized locally. On the opposite some features, even though rather evident when looked at from a short distance, fade away on a larger scale. At different levels, interactions among systems and subsystems vary in quantity and quality, emerge in different ways, shaping social, cultural, economic and territorial processes. Furthermore, as stressed with respect to complex hazardous events, vulnerability analyses have to take into account the different scales of hazards’ impacts and the potential overlapping among impacts due to phenomena acting on different scales and/or to the repercussions of local events on areas placed far from the main event. Therefore, multi-scale and cross-scale analysis cannot be neglected in vulnerability assessment.

### **Taking Resilience into account**

Resilience and vulnerability have been recognized as separate processes, acting in different phases of the disaster cycle, at different levels (individual, communities...), even though characterized by some areas of overlapping. The two concepts can be interpreted as two different “lenses” or conceptual categories, both of them useful for analyzing how a complex system, namely a territory in all its aspects, reacts to an hazardous event. The behavior of a complex system hit by an external stress depends on many factors: some of them can be better categorized and analyzed under the lens of the vulnerability (namely that one related to the ability of an element or a system to resist and to cope with a hazardous event avoiding or reducing the losses), others under the one of the resilience (namely that one related to the ability of an element or a system to change and innovate themselves after the impact of a given hazard).

Therefore, even though the two concepts have to be separately investigated, vulnerability assessment has to take into account the role of resilience, in that the processes of change and/or innovation of a territorial system hit by a hazardous event may modify vulnerabilities,

facilitating vulnerability transfer and redistribution among actors, communities, areas or producing new vulnerabilities.

### **Coping with uncertainties**

Due to the growing complexity of urban and territorial systems, their behaviors in case of external stresses will be characterized by a high level of uncertainty. Thus, based on the consciousness to act in a state of uncertainty, that not all the changes of the variables at stake are predictable, the whole process aimed at analyzing such behaviors through the selection and the measurement of the multiple variables at stake (knowledge phase), at defining measures able to influence these variables (decision phase) and implementing such measures (action phase) would have to be iterative and flexible, taking into account the unpredictable changes of the initial conditions which could occur during the time.

### **Tools for understanding, assessing and communicating vulnerabilities**

An innovative approach to vulnerability assessment requires innovative tools for understanding and assessing vulnerabilities and for communicating technical outcomes to experts from different fields (e.g. land use planners), to decision makers and to communities.

Different tools are currently available for carrying out an integrated and dynamic assessment of vulnerabilities. The choice of such tools is closely related to the aims of the assessment itself. A first one is related to the use of conceptual maps for exploring the complex web of linkages among hazards, vulnerabilities, factors contributing to vulnerabilities and consequences of vulnerabilities in terms of damages. In fact, a conceptual map allows to single out the different types of relationships among the above mentioned elements. Such a tool can be referred to the different phases of the disaster cycle and allow us to explore future scenarios (e.g. due to the change of one or more elements at stake as a consequence of mitigation measures). Moreover, the different elements and relationships can be weighted according to their relevance in a given space and in a given temporal span. Finally, it is worth noting that conceptual maps can be easily understood even by no expert users.

Methods and procedures to integrate vulnerabilities through numerical indexes are available too, even though they consider only some aspects of vulnerability. Numerical indexes are very useful to rank different territories according to their vulnerability and to support choices related to resource allocation. Nevertheless, such methods do not allow a fully understanding of the mutual relationships among the many factors at stake. Such an understanding is very relevant even to explore the consequences of development trends related for example to land use planning choices or to social and economic policies. Moreover, it is worth stressing that such methods generally provide very technical outcomes that are difficult to communicate to no expert users. Hence, even though some tools are available, they require some improvements in order to adequately support an integrated assessment of vulnerability: most of the current methods do not allow to take into account the dynamic features of vulnerabilities, the multiple scales at stake, the need for coupling both quantitative and qualitative information. Moreover, current techniques for representing vulnerabilities are very often not addressed to involve communities in the assessment process, making, even through adequate representation tools, the existing technical knowledge available and sharable.

Methods and techniques aimed at analyzing, assessing and representing the change over time and in space of vulnerabilities will be further investigated in the next WP.