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ENSURE E-LERNING TOOL

F03

Vulnerability in time and space

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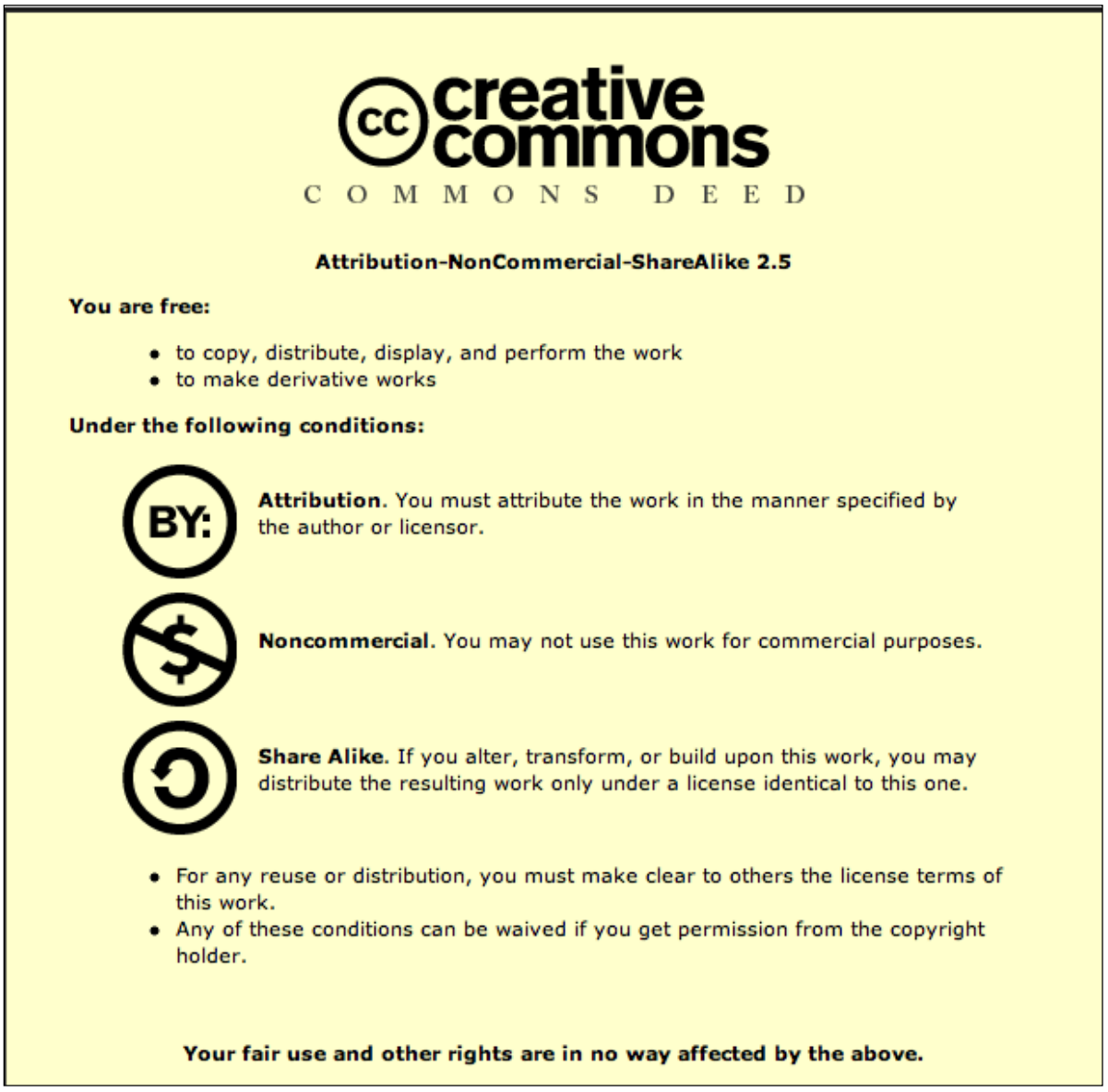

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Vulnerability in time and space

The fact that vulnerability holds a relevant temporal and spatial dimensions is well recognised in literature (while it may be stated that the relationship among different types of vulnerabilities described in WP2 even though well documented has not been at the core of most investigations on vulnerability until now).

With respect to time, several aspects have been considered. First, it was recognized that vulnerability should be considered as a dynamic rather than static concept: vulnerabilities are shaped over time, vulnerabilities that we are able to assess today are the result of historic processes, shaping cities, communities, infrastructures in a way that builds their potential relationship with hazards. On the other hand, different types of vulnerabilities become more apparent and relevant at different stages of the disastrous event: at the impact, physical vulnerabilities transform into the direct physical damage provoked by the event; during emergency and recovery, systemic, social, institutional, organisational factors determine how slowly or how fast return to normalcy will be possible and at what conditions (for example with respect to the possibility/capability to reduce or increase pre-event vulnerability).

With respect to space, two main considerations constituted the ground for analysis: on the one hand the relevance of space per se, on the other the concept of scale.

As for the spatial dimension per se, we may found in literature since long ago, the distinction between places that are differently affected during the same event: the so called core of the disaster, its “epicentre”, where physical damage is more prominent, and the “periphery” of the event, which is directly and/or indirectly involved in the disaster. In fact, different types of long distance effects can be considered: areas from where help will be provided and to where people will be temporarily evacuated in case of need enter into a new type of relationship with the affected areas. New or increased transportation will be required; a flow of goods, services and resources will reinforce and sometime create new linkages. It would be limiting though to consider only the connections arising for emergency and recovery management purposes: remote areas may be affected by the lack of services, by the interruption of major transportation routes or simply because economic relationships exist with the stricken areas, and some firms will be affected by interruption of activities in the impact zone.

The fact that different areas from those directly affected by an extreme event must be considered, leads to the need to enlarge the overlook from the “local” scale to larger scales, considering how the “local” is placed within larger economic and administrative regions. Some authors have stated that vulnerability assessment is inevitably local; the Ensure project aims at challenging such position by showing that a more complex approach is required, because some vulnerabilities are local, or are particularly relevant locally in shaping the damage (like physical), but others make sense only when larger scales are considered (see for example systemic or social, when the latter include administrative and institutional vulnerabilities). The same consideration regarding scales become relevant when the natural environment vulnerability is considered.

Furthermore, some vulnerabilities are actually evident at larger scale because of the nature of the threat and the intrinsic features of systems. The Eyjafjallajökull eruption in Iceland in

spring 2010 showed how vulnerable the aviation system is to the consequences of a volcanic explosion provoking ash clouds endangering flights. A rather “local” event, the consequences of which may nevertheless spread over very large zones; an event that has not provoked significant physical damage, losses or victims, but with a very large impact over transportation system and through the ripple effects in economic activities on the entire aviation industry and on the tourist sector.

Finally the scale at which vulnerabilities are relevant depends on the institutional, economic and social arrangements in the different contexts, making clear that a unique rule for deciding a priori at what scales a certain analysis must be conducted does not make particular sense. The selection of relevant scales will depend on the context, and on the particular way in which different systems are connected and related to each other.

In figure 1 the general working framework of ENSURE is shown: as it can be clearly seen it is deployed over a plan where both the spatial and the temporal dimensions are evidenced. As for the spatial one, the scales at which both hazards and vulnerabilities should be appraised are represented in two distinct axes.

The reason is that not necessarily the scale at which hazards have to be analysed correspond to the scale at which the different types of vulnerabilities must be considered. For example, physical vulnerabilities are mainly addressed at the local scale, as the intrinsic fragility of structures, infrastructures, and people must be looked at in detail at the local scale. What appears at larger scale is the result of such analysis, in terms of comparison among places. As already mentioned, systemic vulnerability can be appropriately considered only linking the local to the large scale (provincial or county level to the regional an sometimes above regional). When it comes to consider the capabilities to recover effectively in a resilient fashion, all scales must be considered: what will be reconstructed is ultimately what has been locally damaged, but the needed resources cut across all levels of government and depend also on the type and strength of relationships among the affected places and a much wider region.

As for the temporal dimension, it is shown how the various vulnerabilities and resilience are considered with respect to the phases of the disaster cycle. Before the impact, that is when a sufficiently long time has passed since the last big event, the mitigation capacities are considered. Rose (2004) suggests that it is more correct to talk about mitigation capacities in the period before the hazard impact, while resilience should define more appropriately capacity to recover from an extreme event. This is nevertheless a matter of deciding the most suitable definition; what is actually relevant here is the attempt to understand whether or not conditions to enhance coping capacity and resistance of a complex system exist or not and how they are manifested. At the impact, instead, the physical vulnerabilities play the major role: the direct physical damage that can be accounted for are strongly correlated on the one hand to the severity of the hazard, on the other to the level of physical fragility of artefacts and constructions. As the time from the impact passes, other forms of vulnerability gain relevance, and in particular during the emergency phase, precisely systemic vulnerabilities. Those express the response capacity (or lack of) not to the direct extreme event impact but rather the consequences of the latter, to the impairment in crucial systems and their components provoked by the physical damage.

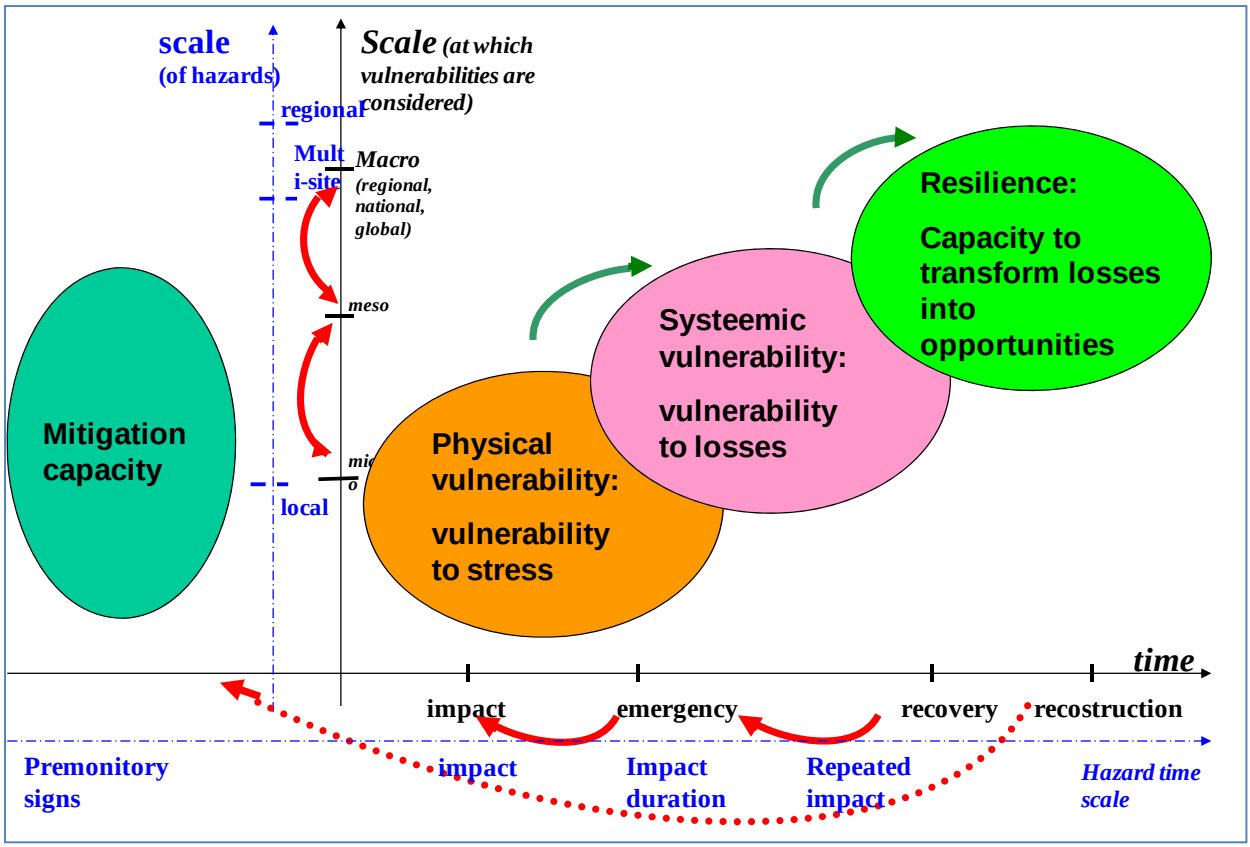

Figure 1: General representation of the integrated framework to assess vulnerability and resilience across time and scales

Finally, considering the time of reconstruction and recovery, resilience gain prominence: here again the response is not to the stress, but to the longer term induced, indirect, secondary effects it has produced. What we want to measure here is not merely a response capacity, but rather whether or not systems is able to recover by reducing pre-event vulnerabilities, to learn from the weaknesses that the event has revealed and to transform reconstruction into an opportunity to build and develop a better, safer and healthier place to live.

The red and green arrows represent the various connections and links that exist among the different types of vulnerability and resilience, in space and time. Those will be tackled in sections ahead.

The issue of scale has been rather neglected or poorly appreciated for a rather long extent, while in the meantime the concept of vulnerability, coping capacity, resilience and related concepts were undergoing a significant evolution process. It has become the centre of interest and studies with the first applications of climate change scenarios, particularly when the latter had to be regionalized, and with the development of the first global integrated assessments of the state of the environment and risks. The main question that the latter analyses have raised regards the relevance for local places but even for regions of projections and scenarios that have been drawn considering global trends and processes, while neglecting the information that can be gathered locally. It was clear for the scientists in climate change and those involved in global environmental assessments that for some phenomena, what happens in a given place, or at a micro level cannot be always neglected, as sometime it may contribute to

change the evolution or patterns at much larger scales. Therefore a reflection on the meaning and use of scale in such studies and conversely in natural hazards has broken through various research groups, producing insightful thoughts that are relevant also for the Ensure project.

First, it should be said that introducing scale into vulnerability and resilience assessments is not easy, nor there are available standards or references that can be taken as a guidance. But even in more general, theoretical terms «improving the understanding of linkages between macroscale and microscale is one of the great overarching intellectual challenges of our age in a wide range of sciences» (Willbanks and Kates, 1999). The authors continue suggesting that «weaknesses in appreciating the interaction of processes moving at different time scales and extents, in fact, underly a great deal of the current scientific interest in complexity, non linear dynamics, and the search for order amid seeming chaos». The issue of scale is particularly important when different scientific perspectives must cooperate together in a truly interdisciplinary way. As suggested by Root and Schneider (1995) «the scale at which different research disciplines operate make multidisciplinary connection difficult and necessitate devising methods for bridging scale gaps». Having said that, it is clear that what can be realistically achieved within the Ensure project is first an explicit recognition of the importance to consider the scale issue as a central one and second a proposal of how it can be operationalized within the proposed methodology.

In accordance with the already quoted definition of vulnerability provided by Turner et al (2003), we may well take the definition of scale as suggested by Gibson et al (2000): «We use the term scale to refer to the spatial, temporal, quantitative or analytical dimensions used by scientists to measure and study the objects and processes. Levels on the other hand refer to locations along a scale».

In the suggested framework, both the spatial and the temporal scales of disasters are considered to structure the analysis of vulnerability and resilience. It is also suggested that even though both concepts are dynamic and dynamism is a crucial aspect to understand how and why given levels of vulnerability or resilience can be “measured” today, what can be practically achieved is a “picture” of frames at meaningful levels of the scale.

In order to operationalise the concept of scale, then two main aspects will be discussed in the following paragraphs: first what are the relevant levels for each scale to investigate for what purpose; second how we may treat cross-level and cross-scale relationships.

Insofar the framework description has provided a static picture of the vulnerability assessment, providing the explanation of what can be viewed as a skeleton comprised by subcomponents and indicators to enlighten and evidence the various factors that have been recognized in literature and past applications as relevant for understanding the potential response of a complex territorial system to the “external” stress due to a natural extreme.

The Ensure team though has acknowledged since the first WPs (in particular the second one) that links, connections, coupling relations exist among indicators. More than that: the validity of a vulnerability assessment requires the understanding of such connections to avoid misleading results that do not take into account how the various factors interact in a real setting.

Given that, the issue of how to play on the relationships that have been sometimes grasped in back analysis within the framework has still to be fully understood.

At least three types of relations can be recognised.

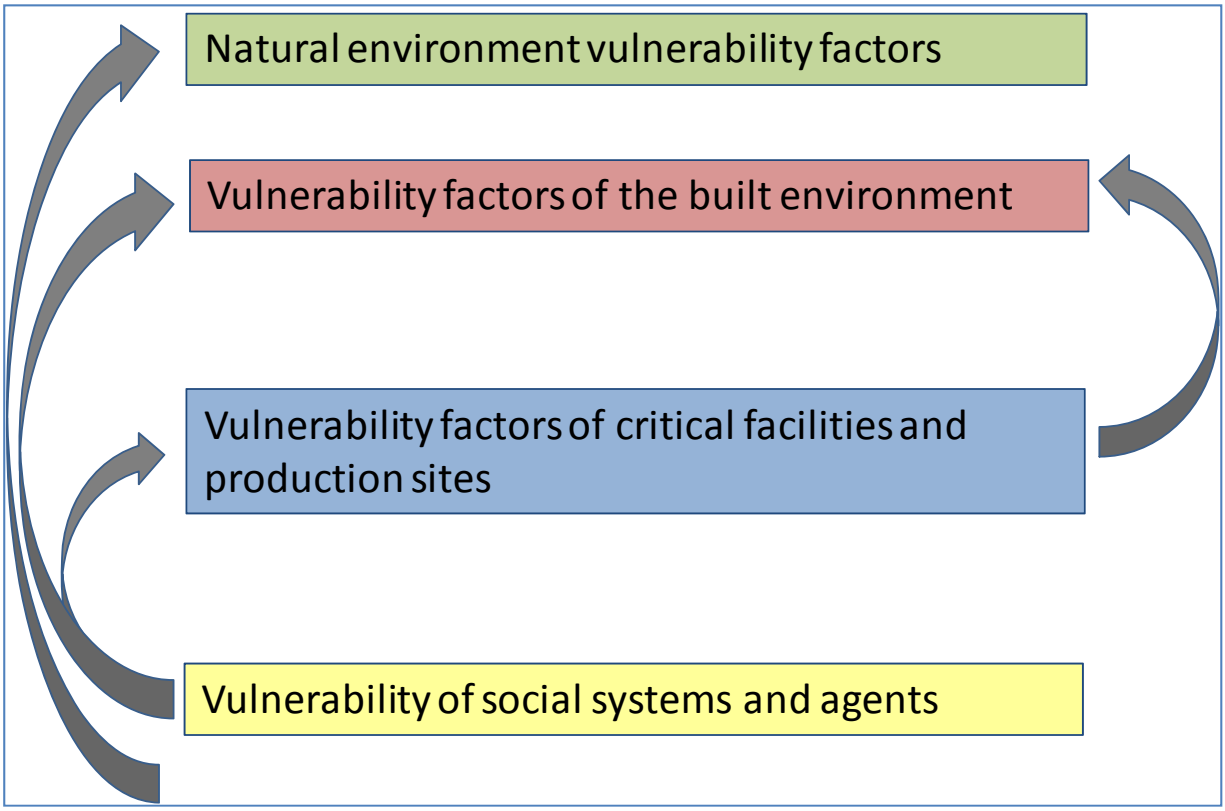

Figure 2: Relations among indicators within the same matrix

The first (see figure 2) relates to how the different indicators within the same matrix may be connected to each other. In general term, it can be assumed that social agents in various forms may have a direct or indirect, strong or loose influence on all other types of vulnerability, that is on the vulnerability of natural systems (for example the decision to change the type of vegetation coverage for economic profitability may induce instability in slopes or give room for more inflammable species), on the vulnerability of the built environment (here the all issue of compliance with norms and state of the art techniques enters), on the vulnerability of critical infrastructures (not only the way they are constructed, but also to what extent they are privatized, whether or not managing companies are controlled, coordinated by public bodies, etc.).

The second and the thirds relate to spatial and temporal cross-scale and cross level connections.

The reason why we need to address the scale issue can be derived from the rather enlightening and systematic discussion by Willbanks and Kates (1999):

- For the “tractability” of the problem at stake: when considering for example the vulnerability of buildings, a one by one survey can be carried out in very small municipalities and in any case only locally; when the vulnerability of entire provinces,

counties or regions must be appraised, sampling techniques or even statistical analysis based on poor data (like census data) has necessarily to be adopted. This does not mean that studies at larger scales are less reliable: they obviously serve another purpose, that is the setting of strategies and policies identifying priorities, rather than deciding about individual interventions. Many other examples can be presented; in general it is true that vulnerability assessments regarding several components of vulnerability are much more tractable at the local scale, and the quality of information that can be gathered is much higher. Nevertheless, the limitations of investigations conducted only at the local level should be pointed out as well. First, the resources necessary to carry out a thorough survey are limited and therefore many localities will not be covered because of lack of time, money, personnel; second, at the local scale some relevant factors influencing trends and conditions can be missed, as they operate at other scales or levels. It is rather hard, perhaps impossible, to identify the "right" scale or level at which to analyze a given problem, as the latter depend on the purpose of the assessment, on the available resources but also, importantly, on the type of patterns and phenomena that have to be investigated. This lead us to the next point.

- A multi-scale, multi-level approach is relevant whenever "emergent" aspects, patterns, relations emerge at higher (or lower) scales and levels and therefore missing them may invalidate the entire assessment. An example is provided by lifelines vulnerability assessment: because of their intrinsic hierarchical structure and of their mutual interdependence, studies conducted at a local level may completely miss the relevant interconnections that are both spatial and systemic. Furthermore not just one level is implicated in infrastructures organization: actually it depends on the specific arrangements in a given country or even continent. Before moving to the analysis of the local vulnerability of lifelines, one must estimate where the vital links, nodes, segments are. In this respect, it may be suggested that physical vulnerability assessment is more likely to be "local", whilst "systemic" vulnerability as defined in the Ensure project is more likely to be grasped at higher levels, regional or national. Following Root and Schneider (1995) a "cyclical scaling" method has to be preferred to rigidly pre-defined "top-down" or "bottom-up" approaches, going from the local to the regional or national and back to the local, depending on the question to be answered with the vulnerability and resilience assessment.
- Considering multiple scales and levels supports even more strongly the need for a methodological strong framework as the one suggested by the Ensure project. In fact, a definite rule valid for all types of assessments cannot be established, as the choice depends on the objective of the assessment but also on the systems to be analyzed and on the specific context where the analysis is carried out. Such a framework, by establishing how given parameters and topics must be addressed at what level and scale, is better fit than case by case analyses to accomplish what Willbanks and Kates (1999) see as key requirements: put localized observations into a reference context; increase the comparability of studies conducted at the same spatial level and across time. This is a requirement that has been stated, even though phrased in other ways, by the Asean group producing the Post Nargis Cyclone assessment of needs and damage in the affected Myanmar areas (2010). The latter shares with Ensure a similar

philosophy, according to which vulnerability and resilience evaluations are useful exercises only at the condition that they support and offer insight for deciding mitigation and prevention strategies.