	ENSURE PROJECT *Contract n° 212045*

ENSURE E-LERNING TOOL

F17
State-of-the-art on territorial vulnerability and natural hazards
Lessons learned

The project is financed by the European Commission by the Seventh Framework Programme
Area “Environment”
Activity 6.1 “Climate Change, Pollution and Risks”

Reference reports:

Del. 1.1.2-3: Lessons learned and research windows opened by the State-of-the-art on territorial vulnerability (chap 1, 2)

creative commons

COMMONS DEED

Attribution-NonCommercial-ShareAlike 2.5

You are free:

- to copy, distribute, display, and perform the work
- to make derivative works

Under the following conditions:

Attribution. You must attribute the work in the manner specified by the author or licensor.

Noncommercial. You may not use this work for commercial purposes.

Share Alike. If you alter, transform, or build upon this work, you may distribute the resulting work only under a license identical to this one.

- For any reuse or distribution, you must make clear to others the license terms of this work.
- Any of these conditions can be waived if you get permission from the copyright holder.

Your fair use and other rights are in no way affected by the above.

Table of contents

1 Lessons learned and research windows opened with respect to territorial vulnerability in case of hydro-geological hazards

Approaches to Territorial Vulnerability: Advancements and future challenges

1. To the scientific and research communities of Hydro-Geological Risks/Hazards on the one hand and Climate Change on the other, the meaning of Territorial Vulnerability reflects propensity to losses of complex geographical entities (to the Climate Change community this propensity includes the generation of exposures and new hazards by these entities) due to a stressor. These complex entities incorporate physical, social, economic, cultural, organizational, institutional micro-units and macro-structures. Territorial vulnerability denotes susceptibility to losses of all above units and structures contained in a territorial entity as well as of their interconnections and linkages. Kindred terms are “geographical vulnerability”, “urban vulnerability”, vulnerability of an area, region etc.

   Some researchers emphasize the “exposure” dimension of territorial vulnerability, others consider equally the “exposure” and “coping capacity” dimensions and there is a third group advocating a three dimensional essence of vulnerability (i.e. one comprising “exposure”, “sensitivity” and “adaptive capacity” or “exposure”, “resistance” and “resilience”). As to the locus and origin of Territorial Vulnerability the exposure component is considered an external factor while other components (i.e. coping capacity, sensitivity and adaptive capacity, resistance and resilience) are considered internal or inherent to the territory / community factors of vulnerability.

2. According to the above various conceptual interpretations, different procedures of assessment of territorial vulnerability exist. Some methodologies start from consideration of vulnerability of the micro-units included in a territory (without ignoring the influence of the wider structures) and proceed then step by step to larger and larger scale units. Other methodologies follow the reverse path; these start from macro-structures and macro-indicators and attempt subsequently indicator specializations and division of the territory to lower scale units.

3. Most approaches do not deal with the root causes of vulnerability, the mechanisms and processes that make a spatial entity (a geographical or territorial unit) vulnerable; they deal instead with the end results, the observable symptoms of vulnerability. They elaborate quantitative and space variable parameters and manage to arrive at mapping results showing the spatial distribution of vulnerability at various scales. In the few cases of approaches and models searching for the mechanisms of vulnerability generation, expansion and transference, no rating of locations / spatial units according to their vulnerability level or mapping results have been achieved.

4. Some of the approaches – which have been reviewed in Del. 1.1.2-1 / chapter 1.2 – are hazard specific, such as the cases of approaches to vulnerability to floods, the CIPE-MURST methodology and the methodology referring to seismic vulnerability of micro-territories in Athens; others refer to groups of hazards (such as the Munich Re and DRI approaches) and a third group of methodologies are hazard-independent or applicable to all hazard cases (e.g. ESPON Hazard methodology, ARMONIA etc). The researchers dealing with single hazard situations consider the determination of vulnerability to multi-hazards as the major challenge of the future. On the contrary, researchers pre-occupied with the general aspects of vulnerability applicable to all hazard cases presume hazard-specific vulnerability as the major issue of the future.

5. While most approaches acknowledge that vulnerability of spatial units is multidimensional as it incorporates social, economic, functional, systemic and physical aspects, this rule is not followed in most of the specific methodologies. Often, although claims are made that multiple aspects of vulnerability are taken into account, the end-result is almost exclusively "physically-oriented" and dependent on land-use parameters, for practical reasons. Some approaches are concerned with social and economic indicators alone (DRI and ESPON), some are pre-occupied with building damages (Munich Re approach) and others focus exclusively on functional and systemic vulnerability (e.g. CIPE-MURST methodology and the methodology for the Italian historic city-centres). In other words each individual approach is not but a partial view of the problem of vulnerability. When for instance "coping capacity" of a district is estimated in terms of availability of emergency equipment and road accessibility indices alone, other aspects (physical, social, economic) are missing (e.g. personal and household mobility issues, education and training aspects, accessible economic and social assets etc.). This means that trade-offs between the several aspects of vulnerability and resilience are not captured. An indicative example is the case of a hospital or a productive firm that activates an emergency electric generator when electricity supply is interrupted due to damages in the electricity distribution network. In practical terms, physical vulnerability may be traded off by organizational resilience and the result as regards overall response may surpass the expectations inferred by estimations of physical vulnerability alone.

6. The relationship between exposure and vulnerability is proved to be the most intricate and disputable issue. At one end we have the DRI methodology considering exposure as an independent, exogenous factor, out of and irrelevant to the intrinsic and endogenous property of vulnerability. At the other end the ESPON Hazards methodology identifies exposure with the damage potential component of vulnerability, where the aggregate of this potential and the coping capacity represents the respective vulnerability level. In between the two extreme cases other methodologies (such as ARMONIA and the methodology for mudflows by DIPIST) avoid mathematical operations to extract composite vulnerability indices. These latter methodologies acknowledge that exposure and coping capacity often have completely different locus and scale of reference and different periods or moments of occurrence. For instance, population's exposure within a neighbourhood unit might be estimated on the basis of population size and density parameters at the

neighbourhood level but coping capacity of the area and its population may depend on road network accessibility at entry points far away from the spatial unit under consideration. Besides, urban factors that aggravate exposure might enhance coping capacity or the other way around. Furthermore, initial exposure in the event of actual disaster may alter the urban landscape (and not alone) in unpredictable ways that undermine the assumptions made for coping capacities in normal periods and hence estimations and projections of the overall vulnerability potential.

7. As mentioned, almost all methodologies, except those focusing on causal origins and the transference mechanisms of vulnerability are based on procedures and parameters that yield mappable results. In a way the methodologies have been built to serve the need for maps that depict spatial distribution of vulnerability to support spatially differentiated measures and policies. However, this rationale presupposes that vulnerability fluctuates solely in terms of space, which is not the case. The immaterial aspects of vulnerability, e.g. institutional vulnerability, are certainly not mappable and these immaterial aspects might affect the material ones or be affected by them. These interchanges are lost altogether by the "snapshots" of single faces of vulnerability. Therefore the efforts to arrive at results that can be represented on maps lead to dangerous simplifications that neutralize the dynamic and non-spatial properties of vulnerability. As we emphasized earlier it is the absence of adequate coverage of institutional vulnerability which is particularly to be deplored.

8. The sociologists' point of view that vulnerability is the composite result of exposure, resistance and resilience (Kasperson et al. 1996; Pelling 2003) is very close to the perception of vulnerability by the Climate Change Community as a synthesis of exposure, sensitivity and adaptive capacity. On the other hand when vulnerability is taken as the product of exposure and coping capacity the latter component is not clearly defined. Does it concern pro-active counter-disaster properties alone? Does it refer exclusively to post-disaster remedies and rehabilitation action or both of the above? Some researchers would like coping capacity to encompass both pre- and post-disaster ability for action; however co-assessment is problematic since it necessitates time compression and equalization of diverse and distant agencies / domains (for instance the population groups living in a district may be exposed to specific hazards to which they respond with their own coping capacity; at the same time they are dependent on the coping capacity of the institutions that assume the emergency operations should a crisis come up).

9. The methodologies differ in terms of their stance as regards the type(s) of losses to which vulnerability refers. In some cases the referred type of loss is explicitly quoted (for instance in the case of DRI); in others it is implicitly derived (e.g. in the case of manufacturing firms in Athens where survival / continuity / closure is at stake); finally there is a third group of methodologies where reference to the loss type is not made at all, implying that the suggested methodology covers all forms of impacts and losses (direct and indirect, primary and secondary, loss of lives, physical damages, economic losses, property losses, disruption of services, operations and processes, bankruptcy or dislocation of firms, business closures

and so on). Indeed, once the losses under consideration are not stated one is allowed, if not encouraged, to include everything. The underlying assumption is that if capacities and strengths are missing anything can happen; the type of impact is irrelevant to vulnerability. However, this is debatable. For instance, dismissals of firms' employees might result or might not result from structural vulnerability of the premises housing the firms; on the other hand it might be the outcome of medium term secondary impacts such as business interruption for a couple of weeks due to lifeline failures or even due to decrease of the annual turnover of the firm as a consequence of disturbances to the wider economic activity in the urban area destroyed. Hence, vulnerability to physical damages and direct loss of immovable assets is something completely different from vulnerability to long term impacts and incapability of survival in the long run. Besides this latter, long term vulnerability is an undesirable property that one can get rid off because it can be externalized to other interconnected agencies. Long term vulnerability is an unwelcome evil that may be easily removed.

10. As already mentioned in most methodologies vulnerability is not assessed as a time variant parameter. It is approached either as an instantaneous property of a spatial entity (e.g. the Munich Re approach at Mega city scale considering vulnerability at a distinct moment) or as if vulnerability repercussions that extend actually over long periods could be piled up at a specific post-disaster moment (e.g. the points of view of DRI and ESPON Hazards project). Time compression here is a problem because needs, capacities and action at the emergency and recovery periods are consequential to first instance, direct losses after the disaster and they cannot be anticipated before disasters but only as probabilities dependent on prior stage eventualities. However, in the real disaster conditions first instant losses (due to pre-disaster vulnerabilities) are followed by waves of coping efforts which may manage short term recovery but lead the temporarily recovered entities into deteriorated vulnerability conditions in the long term. Coping capacity is not always a factor relieving vulnerability and in any case the latter is a time variant parameter.

11. In most approaches, the fact is neglected that vulnerability is closely connected to a locus of reference, i.e. the agency or the system carrying it; in some cases this agency / system is capable of self-regulation and adaptation through learning in some other cases it is not. Anyhow the various agencies in the context of territories interact and some succeed in "unloading" their vulnerabilities (either consciously or unconsciously) to the disadvantage of others. Hence, aggregation of vulnerabilities of the components of a territorial unit (or the subsystems of a system) does not reflect its overall vulnerability. Socio-economic and physical vulnerabilities are not properties of the same entity; they are not independent quantities measurable on the basis of a common measure that can be added up to reflect the vulnerability of a totality.

12. It has been obvious from the above that mapping vulnerability values raises questions. Maps are representations of parameters that are spatially determined and more or less settled and steady in temporal terms. However, vulnerability is nothing of the sort at least

in post-disaster periods; it has to do with dynamic action and movement and undergoes changes from month to month even from one day to another. Surely pre-disaster exposure (in some respects a basic component of vulnerability) is a mappable condition though exposure in our days has become a rapidly changing situation too; but resilience (if we consider it as another component of vulnerability) has to do with inventiveness, it comes up as a product of human knowledge, intuitiveness, innovation, cleverness; it is the creature of the moment. Resilience is a matter of immaterial assets and intimately connected with organizational issues and in this sense it is a non-spatial property therefore non-mappable.

Finally, our review of approaches to territorial vulnerability has shown that they are not only by and large limited, but also that there is a lack of adequate links with the wider study of territoriality and territorial structures, as a separate spatial concern and field of analysis. At this point therefore it is essential to return back to the introduction of the chapter and initiate a deliberation on possible relationships between territorial vulnerability and territorial capital. We do not claim of course that what follows is derived as a conclusion from our review of territorial vulnerability research, policy making and methodologies.

2 Lessons learned and research windows opened with respect to territorial vulnerability in case of forest fire and drought

The territorial aspect of vulnerability in both cases of drought and forest fires is critical and essential. However “territory” in the above cases may connote either a purely ecological territory or a human-ecological system. Hence territorial vulnerability (to droughts and forest fires) is split to ecological vulnerability and vulnerability of complex human-ecological systems.

Ecological vulnerability to forest fires denotes susceptibility of the ecosystem to change as a consequence to fire, the rather in an irreversible fashion. Ecological vulnerability changes with respect to the phases of the forest fire disastrous event. Short term ecological vulnerability refers to the soil degradation risk (hence its locus is on topsoil) and it is determined by pre-event parameters as well as exposure to the same the fire event. Medium term ecological vulnerability refers to probable changes in plant composition and structure that are not curable. Exposure to the fire event and resilience of the plant community are the basic components of this second type of ecological vulnerability. It is noteworthy that unlike hydro-geological hazards the meaning of exposure in ecological vulnerability is connected to the span of time during which the ecosystem suffers the damaging influence of the fire event.

The researchers dealing with territorial vulnerability of human-ecological systems to forest fires consider exposure and vulnerability from a different point of view. At a pre-event stage exposed

and vulnerable territories are those suffering a high probability of fire ignition, i.e. those that are stressed and pressed by mass presence and expansionary trends of human population and socio-economic activities. At the stage of event manifestation (i.e. once fire starts) vulnerability is determined by climatic conditions, land use characteristics, vegetation patterns, species flammability and terrain slope. In this second stage population presence may decrease vulnerability. Hence exposure may carry two meanings, either a socioeconomic / institutional /ecological system that produces fire ignition incidences or a system that is exposed rarely or often, for short or for long to fire episodes.

In the case of droughts vulnerability of a human-ecological system is perceived as opposite to system's robustness. More specifically a system is vulnerable to a drought when its structure, parameters and way of functioning qualitatively change under the effect of drought and cannot be restored afterwards. It is interesting to note that vulnerability is related to a threshold of losses after which damage is irreversible. As in the case of forest fires vulnerability is tightly connected to exposure to the hazard of drought. According to aforementioned definition "vulnerability of a system depends on the strength and duration of the drought", meaning exposure. As regards vulnerability assessment this is based on the damage potential and the coping capacity potential of the system under drought pressure. It ensues then that the approach of territorial vulnerability to droughts does not differ much from the cases of hydro-geological hazards. The difference lies in that in the latter cases damage and coping capacity refers to principally pure manmade systems. Besides the capacity to cope with hydro-geological risks originates basically from the threatened (possibly vulnerable) human-territorial system while the capacity to cope with droughts is a function of both the dynamics of the drought (i.e. hazard) and the capabilities of the exposed human-ecological system (its past, present and future).