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Vulnerability in time



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See References in ENSURE Deliverable 3.1

1 The “Vulnerability Actor” or the “Agency / System Carrying Vulnerability”

Several case studies have indicated that vulnerability is transferred, transformed and/or rebalanced at least by the competent for risk mitigation institutions. This capability of institutions to transfer, re-allocate, redistribute vulnerability in time and space is so evident that allowed to aptly define *Institutional Vulnerability* as “the exposure and vulnerability of individuals, communities or organizations to the uncontrollable adverse consequences of another organization’s critical shortcomings”. But institutions are not the only “Vulnerability managers” or “Vulnerability Actors”. For instance, manufacturing firms resorting to dismissals in an effort to externalize recovery costs after a disaster are in essence Vulnerability Actors managing to transfer part of their vulnerability to labourers (i.e. other social agents). Similarly, Vulnerability Actors were the livestock farmers, after the mega-fires of 2007 in Peloponnese, Greece; these economic/social actors attempted their own recovery by abstracting/engaging for themselves resources (such as land and re-sprouting vegetation) which were vital for the recovery of the stricken by the fires forest ecosystems too. Indeed the affected by the disaster livestock farmers vulnerable as they were (regarding prospects of survival) due to delays and inadequacies of consignments of provender drove their flocks to forest land under regeneration for grazing despite relevant prohibition and the strict penalties provided to be imposed to law-breakers.

The above vulnerability carriers function indeed as “Actors” conscious of their vulnerability, willing to get rid of this undesirable property and being capable of relevant responsive action. Vulnerability Actors are in essence entities capable to change their and others’ vulnerability; for this purpose they employ their adaptive, coping and/or response capacity. These Vulnerability Actors may be *social actors*, ranging in scale from that of the human individual (or the single household) to the national and global communities’; *economic actors*, ranging between the single firm and national economies or the global one; institutional actors (e.g. individual fire or police departments, wider emergency mechanisms at the regional level, a whole political / administrative system at the national level etc). The above actors, irrespectively if they are micro-, medium or macro-scale actors are capable of altering, i.e. managing, to some degree (some to a high others to a low degree), the vulnerability of the controllable or accessible by them forms and quantities of capital (human, physical, social, natural, economic capital). Hence Vulnerability Actors are virtually managers of the vulnerability of a system and facing multiple facets of vulnerability. For instance, a local governance system is susceptible to and may be responsive to a series of losses and failures (loss of lives among the administrative staff, loss of administrative buildings and equipment, communication failures, operation executing failures, planning failures etc). The same holds true for a household even for an individual person.

We are naturally aware that social, economic and institutional actors cannot be treated as if they have the same character and properties. Individuals, households and firms are victims of a disaster in a different sense than institutions (e.g. units of local government, government departments etc.) Therefore the ways they manage their vulnerability and then transfer or rebalance it must be differentiated.

Under the above perspective all accessible or controllable forms of capital by a Vulnerability Actor are simple adjuncts of this Actor or they formulate together a *“Vulnerability managing system”*. Indeed a household exerts some sort of influence over and/or regulates to some degree the vulnerability of its “possessions” and all inevitable linkages with the ecological, social, economic, physical and institutional environment (e.g. vulnerability of family members, own house and interactions with the surroundings, household appliances’ kinship and friendship networks etc). Simultaneously, each (systemic) Actor and his/her/its vulnerability is affected by the vulnerability managing capacities of other actors.

In the case of wider Territorial and Eco-human systems there are of course numerous Vulnerability Actors, all struggling for own survival and recovery, i.e. for vulnerability minimization. Some of these Actors predominate and have determinant role in the formulation of the resulting vulnerability balance.

The *“Vulnerability Actor”* utilizes his/her/its coping, adaptive or response capacity to rearrange and “reset” own vulnerability balance in time, space and among the several vulnerability facets (to various hazards also) only when circumstances call for such re-arrangement. During emergency and recovery periods such efforts of vulnerability curing or re-arrangement are frequent and intense, not only because it is then that own vulnerability mitigation becomes a matter of survival but also because in such periods emerge opportunities for capturing and engaging to own benefit brand new forms of capital for this purpose. Consequently, geographical range and position of the systems functioning as Vulnerability Actors is important not only because these properties determine the degree of exposure of the Actor and hence potential losses and internal vulnerability but also because these properties affect the prospects of the Actor to grasp post-disaster opportunities and capital and boost own response capacity.

Needless to say that we do not wish to imply that vulnerability is a matter concerning exclusively the post-disaster period, given that it is primarily a pre-existing condition. We simply mean that further forms of vulnerability develop during the emergency / relief/ reconstruction period.

2 Vulnerability changes along the successive stages of a single disaster cycle

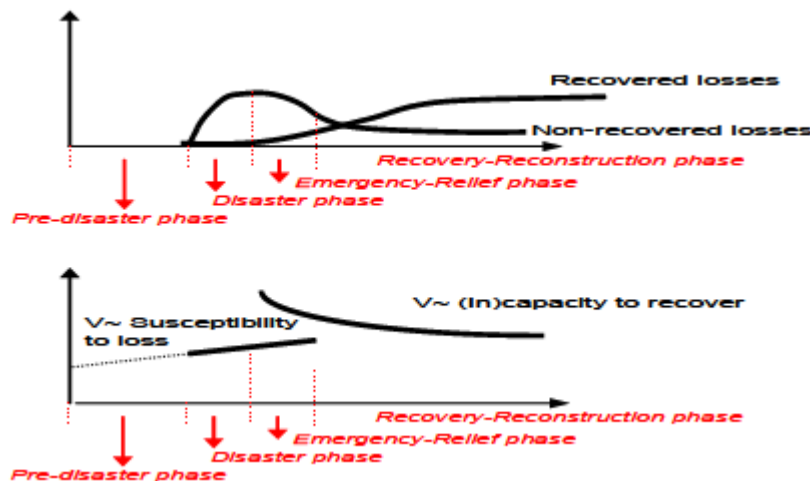
Vulnerability undergoes significant transformations from the pre-disaster (prevention / preparedness) period to the emergency and afterwards to the recovery / reconstruction period.

At first vulnerability is manifested by means of “waves of losses” as several case studies in WP2 connote. More often than not, first order losses are physical and ecological losses owing to vulnerability to stress. These depend on the characteristics of the stress and occur only when these characteristics surpass specific thresholds. These first order losses trigger off first order social and economic losses, eco-systemic, techno-systemic and institutional losses. First order

losses are followed by second order ones, physical and ecological, eco-systemic, techno-systemic and institutional, social and economic, third order ones etc. Each order of losses either on its own or coupled with other orders of the same or different loss categories may produce sequential orders of losses. For instance, loss of jobs may occur again and again (at intervals) after a disaster event as a result of other successive and combined losses and failures, increasing thus gradually the overall unemployment rate out of a disaster.

Except first order physical and ecological losses owing to vulnerability to stress all the rest are basically attributable to vulnerability to loss. In such cases it is the characteristics and extent of the antecedent, causal losses (and relevant thresholds) that determine the resulting types and intensity of losses of subsequent order. Of course, the above continuous and expanding in time and space loss production process (reaching its peak at a certain moment of the disaster cycle) is much more complex when hazards shift from individual phenomena towards “an interactive mix of natural, technological and social events” or to the so called coupled events (natural-natural, natural-technological, technological-technological).

Figure 1: An indicative representation of the changes of vulnerability manifestation through the phases of a single disaster cycle – The role of “capacity to recover”



Viewing vulnerability manifestation through the lens of the distinct phases of the disaster cycle and by taking into account the definition of Vulnerability as “vulnerability to stress and the capacity to recover”, one can distinguish accordingly:

- (a) *From prevention to the disaster phase*, where vulnerability is manifested almost exclusively as “susceptibility to loss”.
- (b) *Emergency and relief phase*, where vulnerability is manifested as both “susceptibility to loss” and the “incapacity to recover”.
- (c) *Recovery-reconstruction phase*, where vulnerability is manifested almost exclusively as the “incapacity to recover” (see figure 2)

It ensues from the above that vulnerability in the pre-disaster and disaster phase (up to the emergency phase) is largely affected by exposure (both to stress and to potential or actual

losses). However, exposure here is meant in the widest possible sense, i.e. as a function not only of location in the geographical space but also of position in the social, economic, political, psychological and technological hierarchy (always in connection to the hazard). On the other hand vulnerability in the emergency-relief phase is affected by both susceptibility to loss (and hence exposure) and response capacity while in the recovery-reconstruction phase vulnerability is fundamentally a matter of response capacity (and hence the resources which are essential for recovery in the form of physical, natural, social, economic, cultural capital). This should not make us forget that the preconditions for a high or low response capacity are formulated (to a large degree) by processes that take place during normal periods.

The above consideration refers of course to the vulnerability to the initial hazardous event. Should a second hazard (as an independent event or triggered off by the first hazard) appear in the scene soon after the first several facets of vulnerability and to multiple hazards will simultaneously emerge. It follows from the definitions adopted in WP2 (see T.2.3) that the course of each one of the vulnerability facets (physical, ecological, systemic, social, economic, institutional, territorial) through the stages of the disaster event is determined by the respective evolution tracks of susceptibility to loss on the one hand and capacity to recover on the other.

3 Vulnerability evolution through successive disaster cycles

From a case study analysis, it becomes evident that some systems manage to have decreased their overall vulnerability (by their response capacity) once the disaster cycle has been completed; however, other systems may find themselves in a worse off vulnerability position when they reach the end of this cycle. This means that these disadvantaged systems enter a new disaster cycle from a deteriorated starting point in comparison to that of the previous disaster event. As long as this process of deterioration keeps on the systems will suffer more and more losses after each subsequent catastrophic event; or in other words the thresholds of hazard features which provoke losses when surpassed will become lower and lower after each subsequent event.

Reference to the dynamic effects of vulnerability which is left in the aftermath of one disaster on the next disaster in the same place (and hence to the issue of vulnerability evolution through a series of events) is also made in Del.2.1.1 (section 5.4). In particular, the relevant extract reads (p. 68):

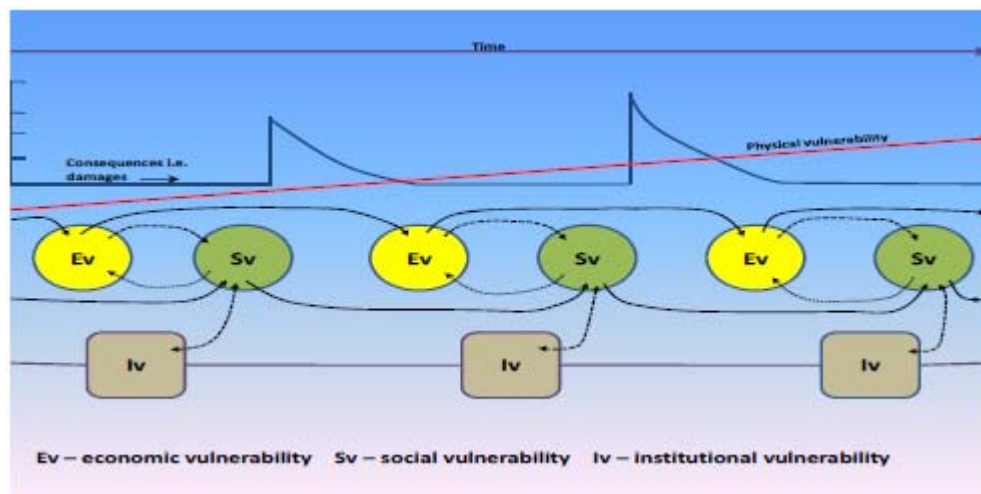
"It is clear that one disaster and the condition in which it leaves an exposed population after reconstruction and recovery may lead to a level of vulnerability which may either reduce or increase the effects of the next disaster. This dynamic contains within it feedbacks and cycles of influence-feedback-influence"

Besides, authors of Del.2.1 have elaborated a figure (Fig. 3) to depict in a simplified form an integrated conceptualization of how economic and social vulnerability are related through “influence-feedback-influence cycles” which take place continually over time. The portrayal is actually a snapshot of a fairly lengthy period (50 or 70 years). It is evident from the figure (that it covers a period of two successive disaster cycles) that institutional vulnerability makes inputs over time. As authors (Del.2.1, p.74) suggest:

“In this example institutions are incapable of holding back a steady increase in physical vulnerability over time, especially exposure of more and more people and assets to hazards....but in another case physical vulnerability might be declining over time, perhaps as institutions become more effective by introducing counter-vulnerability policies” .

Indeed the objective here is understanding, analyzing, assessing and representing evolution of the several facets of vulnerability over a long period the milestones of which are the manifested within disaster events; additional objective is correlation between evolution lines of the several vulnerability facets and the respectively determinant factors / parameters.

Figure 3: Economic and social vulnerability relations as ‘influence-feedback-influence cycles’ over time with inputs of institutional vulnerability in a situation in which economic growth is leading to rising physical vulnerability (particularly exposure) and the consequences of periodic disaster events lead to consequence spikes (Source: ENSURE, T.2.1, Section 5, p. 69)



A note of caution is in order here in connection with the dimension of time as treated in this section and elsewhere. The cycles mentioned here can be very lengthy and this raises all sorts of questions with regard to what affects vulnerability, coping capacity etc. In a period of several years, let alone decades, we cannot predict the inputs that will affect the situation when another disaster strikes in the distant future. Everything is bound to be different then, from infrastructures and technology to the structure of the productive system and the social conditions. We wish to draw attention to the fact that during the full disaster cycle it is not only the processes associated with the disaster (or chain of disasters) that count, i.e. processes of vulnerability management, reconstruction etc. When the cycle lasts for a long period, the rest of the world does not remain unchanged. Several changes are certain to occur in the economy

(e.g. change of product demand), in society (e.g. absorption of the unemployed in new forms of employment locally or in nearby locations), in technology (making obsolete pre-disaster production methods or transport facilities), at the regional, national or supra-national level (e.g. an upturn in the economy or a new configuration of international trade) etc. At the end of the cycle the overall image may be totally different irrespectively of what the disaster-stricken actors or the relief authorities do. The danger therefore is to attribute the vulnerability conditions which develop or remain at the end of a cycle as being the exclusive outcome of the actors' actions with respect to the disaster event. This is a pitfall we must avoid. The problem is that vulnerability at the end of the recovery – reconstruction stage will bear the marks of a host of other developments and factors.

4 Methodologies for approaching vulnerability evolution in time

Temporal fluctuations of the distinct vulnerability facets and their mutual interactions: critical factors

The “unfolding of losses” and hence “vulnerability manifestation and evolution in time” might be viewed in 3 alternative ways:

1. by addressing probable standard courses and sequences of types of vulnerability to stress and types of vulnerability to loss (and relevant determinant factors)
2. by identifying the different vulnerability stages in connection to (a) susceptibility to loss and (b) capacity to recover (for each case of vulnerability facet) and respectively determinant parameters
3. by indicating how certain vulnerability facets influence the development of others along the stages of a single event or over a period defined by a series of events.

With regard to the first approach it is important to remind that vulnerability to stress is restricted to only some aspects of physical and ecological vulnerability. All the other facets (institutional, systemic, economic, social, territorial) are actually cases of vulnerability to loss and their manifestation comes only after physical and ecological vulnerability to stress. Worth-reminding is also the fact that vulnerability to stress is dependent on the features of the stress (thresholds of these features), while vulnerability to loss is dependent on the intensity and other characteristics of the provoking losses (actually thresholds of these characteristics). A challenge here is to specify the critical – in each case – thresholds of stress characteristics and loss characteristics. Another challenge is to interpret and represent the transition from vulnerability to loss to vulnerability to new stress.

With regard to the second approach, it is important to qualitatively and quantitatively approach the vulnerability stages in correspondence with the disaster cycle stages. As already discussed

above, the disaster stage is predominated by the vulnerability component that refers to “susceptibility to loss”. Hence crucial query to be answered with regard to the “disaster stage” of vulnerability is susceptibility to loss of all exposed forms of capital in connection to the characteristics of the stress. Indeed in each case of hazard some forms of capital are influenced and exhibit losses while other forms are not impaired. Degree of losses or impairment depends on geographical exposure and the position of the exposed element in the social, economic, political, psychological, technological hierarchy). On the other hand the “emergency stage” of vulnerability is predominated by the interaction between susceptibility to loss and response capacity. The critical query here is how and to what extend response capacity might alter susceptibility to loss and vice versa. For instance, what happens if the forms of capital necessary and vital for response capacity have been susceptible to loss and vulnerable at the precedent disaster stage? Finally, vulnerability at the recovery stage seems to depend on the availability of accessible forms of capital which are conveyable to recovery. Here vulnerability is determined by previous stage losses – and hence vulnerabilities – and by the probable lack of the demanded forms of capital.

This approach can be largely facilitated by considering the role of resilience in supporting a system’s coping/response capacity and hence in vulnerability changes over time. Among the quoted definitions the following might be helpful to the present approach: *“Resilience is the ability of a system (a) to develop inherent resources and means usable for response and recovery and/or (b) to extract means and resources from the social, economic, political and ecological environment to engage and commit them consequently for the purpose of own response and recovery or for improving own position”*. The case studies and conceptual models developed during ENSURE activities use or test the above definition as well as the key dimensions/features of resilience, i.e. diversity, redundancy, self-organisation, innovation, memory, experience, learning capacity, transformability, cohesion, efficiency, resistance, robustness, collaboration, interdependency, autonomy, resourcefulness, spatial pattern, networking, individual capacity, self-reliance, feedback, flexibility, spatial and temporal scale interactions.

With regard to the third approach this is perfectly illustrated by figure 3 above, showing *how economic and social vulnerability relations as “influence-feedback influence cycles” over time interrupted by inputs of institutional vulnerability lead up to rising physical vulnerability (particularly exposure) and the consequences of periodic disaster events lead to consequence spikes (in a wider context of economic growth)*.

“Vulnerability Actor” as the master of vulnerability changes over time

The present methodology is based on the notion of “Vulnerability Actor” as an entity / system carrying vulnerability and being capable of performing response / management attitudes for the purpose of survival, recovery or effective adaptation to adverse events (shocks) and hence for the purpose of reducing own vulnerability. The above response attitudes and their impact on actor’s own vulnerability vary over time, i.e. from one stage of the disaster cycle to the next and from one catastrophic event to those that follow. It becomes evident that vulnerability changes in time are dependent on the above response attitudes and that it is essential for our analysis to examine the standard features of such responses in a systematic way. Essential is

also the examination of the respective impacts on vulnerability of both the Actor taking the initiative and others as well. Such a systematized analysis might include the following steps:

- (a) Address the Actor performing the response process and identify the disaster cycle or cycles of concern;
- (b) Approach the Actor's initial vulnerability by identifying actual (or potential) losses (referring to the types of capital accessible to or controllable by the Actor);
- (c) Identify the resources (forms of capital) committed to the response process (performed by the Actor), its spatial and temporal range and respective modus operandi;
- (d) Assess the final outcome, i.e. repercussions on own and other Actors' vulnerability.

The above steps are described and explained further in the following paragraphs.

- (a) Address the Actor performing the response process and identify the disaster cycle or cycles of concern: Once a researcher centres its interest on a specific hazard confronted over time or a specific disaster cycle, he/she will obviously locate numerous Actors attempting to manage their multi-faceted vulnerability. However, specific types of Actors appear again and again (for instance in the context of a specific disaster cycle) to display standard behaviour and response against their vulnerability. For instance, after the Mt Parnitha earthquake (Athens 1999) and in the recovery period most of the Small Manufacturing Firms in Western Athens avoided public support for recovery and the relevant "expensive" statutory procedures. Instead they favoured solutions externalizing recovery costs, such as gaining support from their suppliers in the form of credit, making extemporary self-repairs, proceeding to dismissals, failing to pay forced contributions etc. Evidently here, a micro-scale Actor performs a standard behaviour towards its vulnerabilities: The Actor prioritizes curing of its short term economic vulnerability by deteriorating its physical in the long term and by transferring social vulnerability to "the controllable" powerless social Actors. In this example it is worth noting that the Actor "Small Manufacturing Firm" covers not only the economic organization but all sorts of its constituting elements or attached assets (i.e. the controllable and accessible by the firm forms of capital). It is also worth noting that the Actor's decisions regulate vulnerability of all attached to the Actor forms of capital. Hence, identification of the Actor includes also localization of the various forms of capital attached to this Actor.
- (b) Approach the Actor's initial vulnerability by identifying actual (or potential) losses (referring to the types of capital accessible to or controllable by the Actor): Here, the researcher's study should cover all forms of vulnerability at stake, short and long term, physical, social, economic, systemic, i.e. all those suffered by the Actor. Hence, of interest are all forms of loss, failure and exposure (actual and anticipated) of the capital attached to the Actor. In the case of the Small Manufacturing Firms mentioned above, possible losses and failures include material and immaterial ones (building damages, loss of lives among the labour force, interruption of water, energy, communication and other supplies, loss of clientele, loss of suppliers, turnover reduction, prospects of closure). To use another example, households may suffer as a result of an earthquake disaster, from loss of lives, loss of sources of income, property losses and/or become homeless and displaced from friendship and neighbourhood networks.

The researcher who investigates Actor case histories out of a disaster event has to record both the manifested aspects of vulnerability and those that were not ever manifested because of the choices and respective responses of the Actor himself who intervened and intercepted this manifestation.

(c) Identify the resources (forms of capital) committed to the response process (performed by the Actor), its spatial and temporal range and respective *modus operandi*: The resources and mechanisms employed by an Actor during Actor's response process are the most determinant factors of the final outcome, i.e. the impact of this process on Actor's own and others' vulnerability. The resources tapped in an adaptation process (in pre-disaster terms) or a response/coping process (in post-disaster terms) is resources extracted from the then accessible or reachable by the Actor forms of capital (natural, financial, human, social and physical). However, the researcher should bear in mind that the pools of resources which the Actor appeals to in the emergency and recovery period are not the same as in pre-disaster terms. In post-disaster contexts emerge new and extraordinary forms of capital that are latent, inaccessible or completely missing in normal periods (Sapountzaki 2007, see also Del.2.2).

Examples of such extraordinary resources are ad-hoc disaster recovery funds, post-disaster networks of social trust and solidarity, opportunities arising from the disruption of formal rules and statutory regimes of normal periods, networks of donation and special financial support, special recovery-oriented institutions, prior experience and respective social knowledge, memory and ethics, parallel structures of illegality etc. For instance, in post earthquake and other emergencies, and only then, public space may be available to private occupation by the homeless, for the purpose of emergency sheltering. These resources (material and immaterial) are very useful to recovery and combating own vulnerability during this late stage of the disaster cycle. Actors who manage to engage and employ a larger part of the available post-disaster capital, these Actors will probably achieve higher rates of vulnerability decrease and lower eventual levels of vulnerability (out of the disaster cycle). But these "successful Actors may dispossess other Actors (individual or collective) from resources vital to their recovery and hence restrict their possibilities for vulnerability reduction. Indeed, post-disaster arenas are fields of struggle and competition among Actors for recovery resources. Public policy measures are only one among several types of such resources. Besides, institutions are themselves one of the several types of Vulnerability Actors.

One important issue for identification and recording of the resources committed to Actor's response against own vulnerability (and resulting to vulnerability redistribution in time and space) is the spatial and temporal range/scale of these resources. Actors strive to attract the resources they need for coping and adaptation from a whole range of scales and levels of socio-economic, physical, institutional space. For instance, private individuals seek the support of family members as well as neighbours, community associations, even expatriate relatives and friends in foreign countries. All those facing an adversity recall all potentially accessible resources, both those at hand and those remotely available. An actual example quoted in an article by Sapountzaki (2007) will probably illuminate this general principle:

“When the head of a household affected by a disaster sends the most vulnerable family members off to distant relatives away from the stricken area and at the same time stays in a temporary emergency shelter provided by the government in order to supervise the reconstruction of the damaged family house, he/she conducts a process appealing simultaneously to three scales or levels: That of the site of the households’ landed property, that of the space of the households’ social and kinship networks and a third one of the Governmental level provisions”.

Recording of the resources employed by an Actor during the adaptation to or coping with a hazard and vulnerability process might be accommodated by the following table (Table 1).

Table 1: Identity of resources employed in adaptation and response/coping processes by Vulnerability Actors

<i>Resources</i> <i>Stages of the disaster cycle</i>	<i>Forms of Natural Capital</i>	<i>Forms of Economic Capital</i>	<i>Forms of Human Capital</i>	<i>Forms of Social Capital</i>	<i>Forms of Physical Capital</i>	<i>Extraordinary forms of post-disaster capital</i>	<i>Spatial scales / levels appealed to by the Actor</i>	<i>Temporal scales/ range of tapped resources</i>
<i>Pre-disaster adaptation</i>								
<i>Post-disaster response</i>								

(d) Assess the final outcome, i.e. repercussions on own and other Actors’ vulnerability: The aim of this step (and with reference to the time span of a single disaster cycle) is assessment of the residual vulnerability, i.e. the part of vulnerability that the Actor retained (after the efforts of adaptation and response) at the end of the recovery reconstruction stage. This end is at the same time the starting point of the subsequent disaster cycle.

In cases of Territorial and Eco-human systems it is obvious that these involve multiple types of Actors where each Actor type represents numerous Actor cases. The deductive approach is inevitable in such cases; the researcher has to elevate the predominant Actors in each stage of the disaster cycle to study consequently vulnerability transferences between them, internal temporal re-allocation and vulnerability rebalancing for the group of the pre-dominant Actors to finally estimate vulnerability balances at the end of the recovery phase.

A similar approach can be followed -after appropriate adjustment- for a longer period covering more than one disaster cycles. In this case one has to consider changes in vulnerability balances after each successive disaster cycle.

The prescribed method pre-supposes data availability as regards response attitudes of specific exposed or victimized Actors from mitigation to recovery and overall impact of these

behaviours on own and others vulnerability. It presupposes also data availability as regards attitudes of other Actors, those that can have an influence on the vulnerability of the specific Actor under examination.