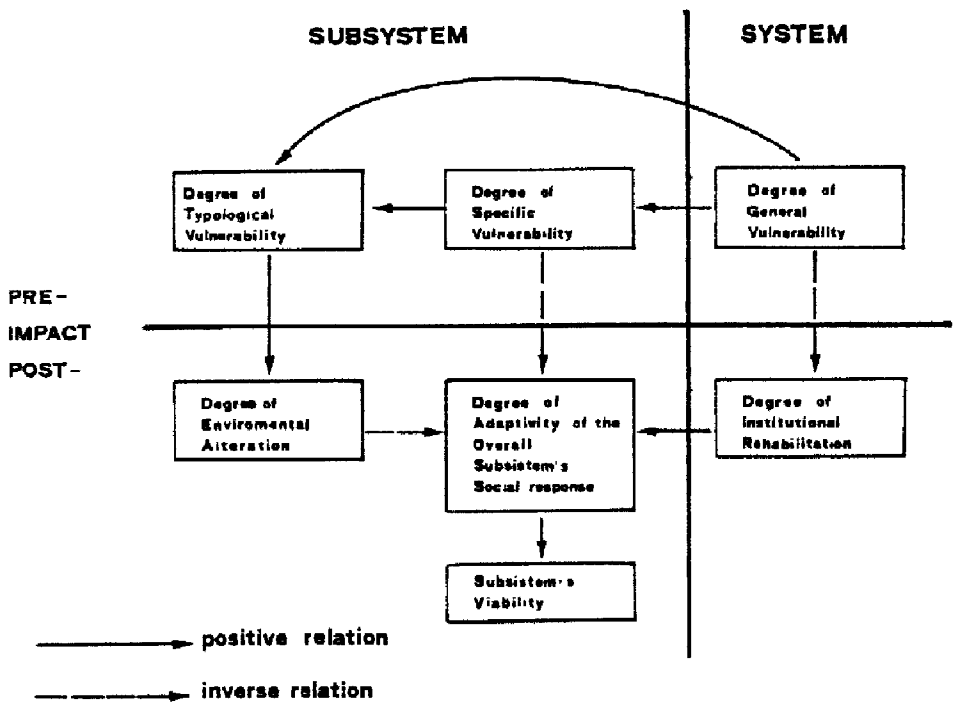
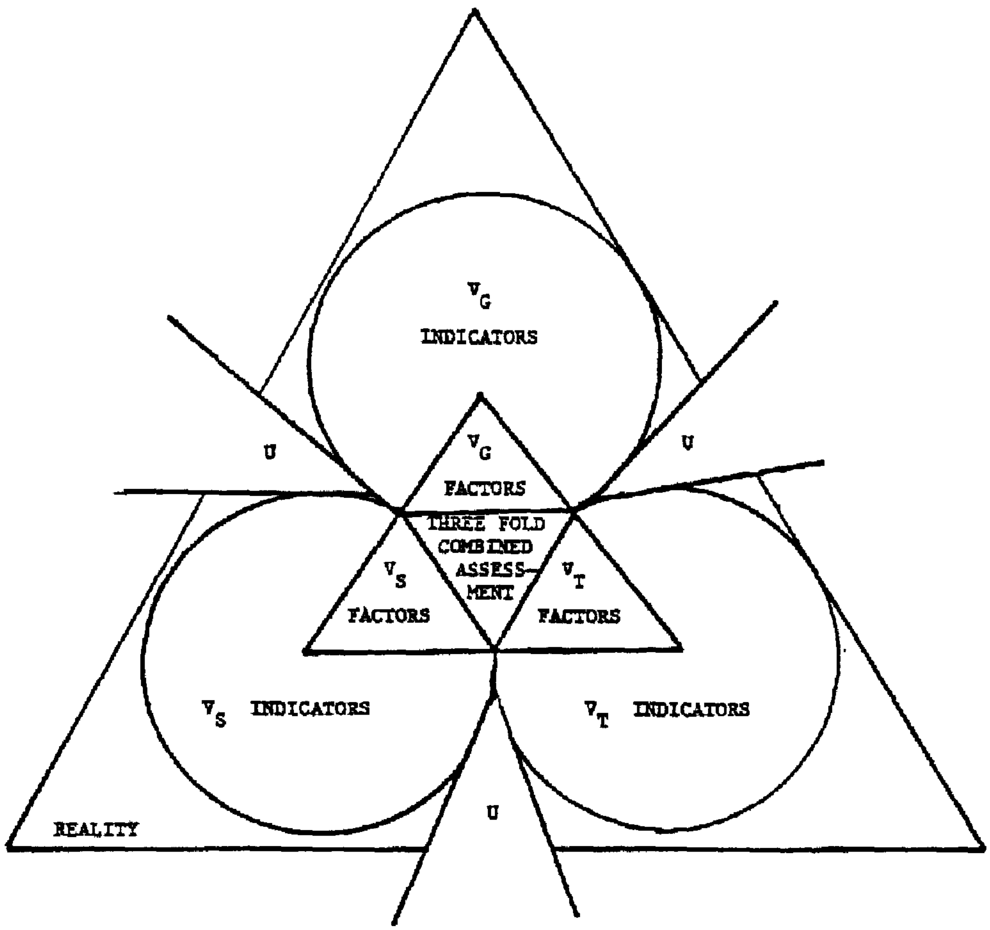


Figure 2

Role and Interaction of Three Levels of Sociosystemic Vulnerability in Determining the Overall Subsystem's Vulnerability and Disaster Response



V_G : General Vulnerability
V_S : Specific Vulnerability
V_T : Typological Vulnerability
U : Unknown Processes and Relations

Figure 3

Representation of a Three-Step Measurement Process for the Assessment of the Overall Subsystem's Sociosystemic Vulnerability dimensions which synthesize them; 3) combined assessment of the factor analysis derived indexes, and their causal relationship, to obtain the degree of overall social vulnerability of a societal subsystem for any chosen set of unwanted possible events.

This is the minimum we believe that is required. But obviously, after accepting the idea of the simultaneous employment of indicators related to all the relevant levels of sociosystemic functional interconnections, we could use many other techniques. For example, to perform risk analysis, we could employ the Monte Carlo Method and the related Network Analysis, or the Delphi procedure, or the Event Tree Analysis, and so forth. We think that the problem of choosing the technique which better fits the researcher's goal follows, and does not precede, the problem of being able to pursue a holistic approach.

The point of view expressed here might satisfy a preliminary introduction to the problem of assessing the degree of the social subsystem's vulnerability for every given set of perturbing events, but it is only a rough idea of what is necessary. Among the many difficulties, one is particularly crucial. In fact, if we could operationalize our approach, we would find not only difficulties in dealing with the large number of required indicators, but, above all, the crucial problem of having to use different criteria of vulnerability per any chosen level of socio-systemic complexity.

Employing only one common criterion for assessing the vulnerability related-state of all the sociosystemic components of interest would be a better strategy. But we have to find something which could fit this goal. In this perspective, our preliminary working hypothesis is that the degree of (in)determinacy of the structural state of a social (sub)system could be functionally related to its overall degree of social vulnerability [Pelanda, 1980].

In the following and final section, we will try to suggest some tentative considerations about the hypothetical possibility of employing an indicator of the degree of sociostructural (in)determinacy, for assessing the overall level of vulnerability of a social (sub)system. The discussion will be necessarily short and incomplete because of the tentative and preliminary nature of our untested hypothesis.

5. Sociosystemic Vulnerability and Bounded Indeterminacy: A Tentative and Preliminary Approach

The problem is to find only one indicator of vulnerability which can be compatible with any structurally relevant component and/or level, placed along the continuum of sociosystemic complexity. If one believes in the possible existence of such an indicator, then the preliminary methodological step is to identify the simplest, theoretically acceptable dimension which could fit any element of the system(s) under analysis. Our point of view is that the degree of (in)determinacy in the structural relations among social system, subsystems and components could be functionally related to their degree of sociologically relevant vulnerability. A necessarily short general discussion justifying this tentative approach is required.

We define a social system as a particular type of cybernetic system in which all the components are interconnected and have a certain degree of autonomy (for a general discussion see Buckley, [1968] Katz, [1981]). By logic, the behavior of any component could be viewed as totally determined, relatively undetermined, or totally undetermined.

If the behavior of all or many of these components is highly undetermined, we could say that the structural state of the system is characterized by high levels of disorder and unpredictability in its functional connections. The opposite situation could be viewed as a state in which the behavior of any component is highly determined and therefore the structure is extremely rigid. A great amount of structural rigidity implies that there is not sufficient elasticity for absorbing some possible unexpected event.

Let us assume two systems whose structure is characterized by, in the first, extreme indeterminacy, and, in the second, extreme determinacy. In both cases we could predict that, for different reasons, there is a similar high level of vulnerability. In the first case this is because there is a lack of structural control over those social and environmental processes which potentially can lead the system to a disaster situation. In the second case, it is because the structural organization has not sufficient variety (e.g., alternatives) for adaptively reacting to an unpredicted event.

This abstract consideration implies that there is an optimal level of indeterminacy in the structure of a system, where a sufficient degree of variety combined with a high but not extreme level of order (determinacy), maximizes the probability of reacting to the actualization of an unpredicted event, by adopting the required inelasticity. We define this optimal level of indeterminacy as "bounded indeterminacy" [see: Katz, 1974] [Pelanda, 1980]. We can measure the degree of indeterminacy of the structure of a given system along a continuum of indeterminacy-determinacy (i.e., 0 = max. indeterminacy; 1 = max. determinacy). We assume that there exists an interval along this continuum called "bounded indeterminacy", in which the system's structure maximizes the required levels of both variety and organization for minimizing or avoiding all types of potentially destructive events. If the system's structural state goes beyond the limits of bounded indeterminacy towards the extremes of both determinacy (rigidity) or indeterminacy (disorder) then its degree of vulnerability rises.

Let us give some conceptual examples for clarifying the latter statement. One of the smallest units of social structure are roles. They could be viewed as packages of expected and socially enforceable behavior. Their interaction makes up role systems [Katz, 1974]. If we observe some individuals who are playing social roles, we could find that the interaction is functional or possible as long as the role-playing remains within the socially defined limits. If the role-playing goes beyond these limits in the direction of both extreme indeterminacy and determinacy, a dysfunction in the involved social interaction is more likely to occur.

Let us change the level of observation and let us assume, from a macroscopic point of view, that a social system reproduces its structure over time. If there is a rigid (i.e., highly determined) reproduction of the original matrix we could say that such a social system is at a steady state, and it does not increase its levels of variety, organization, development. If the process of reproduction generates a new structure which is highly different from the former one we could say, roughly speaking, that the social system has lost its structural stability at a certain point over time. In both cases, we could predict an extremely high level of social vulnerability. In the first case, this could be because of the rigidity in the structural dynamics. In the second case, this would be because of too high an uncertainty in the social processes. Only a bounded change from the former structural state makes a social system able to increase its levels of organization and variety, maintaining at the same time its already established structural stability. In other words if a structural change occurs within the limits of bounded indeterminacy we assume that it maximizes the organizational resources for coping with all the events which could lead the system below the threshold of minimum viability.

In general terms, if we observe the behavior of an organization we could find that both extreme determinacy (e.g., centralization, rigid hierarchy) and indeterminacy in the structural connections among components produce some dysfunction. The situation in which any component has a relatively high but structurally bounded degree of freedom maximizes the probability of avoiding or minimizing the organizational collapse under unexpected tasks.

The function of a limited degree of indeterminacy in the structure of systems is well known in both the daily experiences of engineers and planners and in the scientific work undertaken with systems. In the latter sector, particularly, the recent evolution of all the scientific disciplines shows a great interest about the role of indeterminacy in the life of both man-made and natural systems. We can only mention some examples incidentally in the context of this paper.

How a system maintains or increases order in its interaction with environmental variations is an important question in many disciplines. Von Foerster [1960], criticizing Schrodinger's [1945] principle of the "order based on order" observed that a self-organizing system does not feed only upon order and formulated the principle of "order based on disorder" (i.e., noise, indeterminacy). One of the basic findings in the first developments in the science of cybernetics was an assertion that as an automaton increases its complexity, a certain quantity of indeterminacy (e.g., redundance and delocalization of both the functions and the components) is required for maximizing its probability of adaptation to a perturbation [see: Von Neumann, 1956] [Winograd, 1963] [Cowan, 1965]. This latter consideration is at a certain degree related to the Ashby [1958] law of "requisite variety". Atlan [1972], generalizing a finding which Eigen [1972] obtained in biochemistry, formulates the principle of "noise (i.e., indeterminacy) as a principle of self-organization". It states that a certain degree of indeterminacy in the structural processes of a self-organizing system is a required pre-condition for transforming a perturbing event by generating an increasing level of organization, complexity and variety. Closer to our purposes, a sociological hypothesis suggests that

> ...indeterminacy needs to be, and can be, explicitly incorporated into theories that describe the structure of systems. (We do it) by proposing that there exists a phenomenon of bounded indeterminacy within many systems. The boundedness, i.e., the limits within which

there exists indeterminacy, can be specified precisely while at the same time, accepting the unspecificability of what lies within these limits" [Katz, 1979, p. 394].

Going back to the specific topic of this paper, from our point of view the probability that a perturbing event (i.e., disaster, threat) will activate a process of increasing organization in the involved social (sub)system is the key dimension which defines its overall degree of social vulnerability. Our hypothesis is that a social (sub)system's state in which all the structurally relevant components are operating within the limits of bounded indeterminacy maximizes this probability.

The main assumption of this approach is that such a structural state is the optimal pre-condition for having the maximum availability of the required organizational resources for coping with <u>all potentially destructive events</u>.

To synthesize we believe that:

A) There is a theoretically justifiable possibility for measuring the degree of (in)determinacy of all the chosen structurally relevant components of a social (sub)system.

B) The probability of both maintaining order and increasing organization inside a social (sub)system under perturbation, could be seen as a function of the degree of (in)determinacy in which it and its components operate during the "normality" phase.

If we assume a continuum 0 - 1 along which we can measure the degrees of both social vulnerability and structural (in)determinacy, then our hypothesis could be represented as shown in Figure 4. According to our preliminary and rough conceptualization, we assume that the overall vulnerability of a social (sub)system and its components is at a relative minimum when their structural dynamics operate within the limits of bounded (in)determinacy (see Figure 4). Such a structural state maximizes the (sub)system's and components' probability of absorbing a perturbation (or threat) by generating positive social change and increasing organization variety. The related statement we propose to subject to falsification asserts that: <u>if the dynamics of all the structurally relevant sociosystemic components operate within the limits of "bounded indeterminacy", then the overall degree of social vulnerability is at a relative minimum</u>.

Going back to the starting point of this section, we believe that the degree of sociosystemic (in)determinacy could be the best single dimension or indicator of upper level, for assessing the overall structural vulnerability of a social (sub)system, for any type of possible disaster. This is a tentative and only a conceptually based approach. In future work we will try to falsify this preliminary hypothesis. Meanwhile, we believe that it might serve as a heuristic tool for developing holistic and concretely manageable methodologies of sociostructural vulnerability analysis. To find the most powerful and simplest indicator of social vulnerability is one of the main preliminary goals for applying disaster minimization strategies.

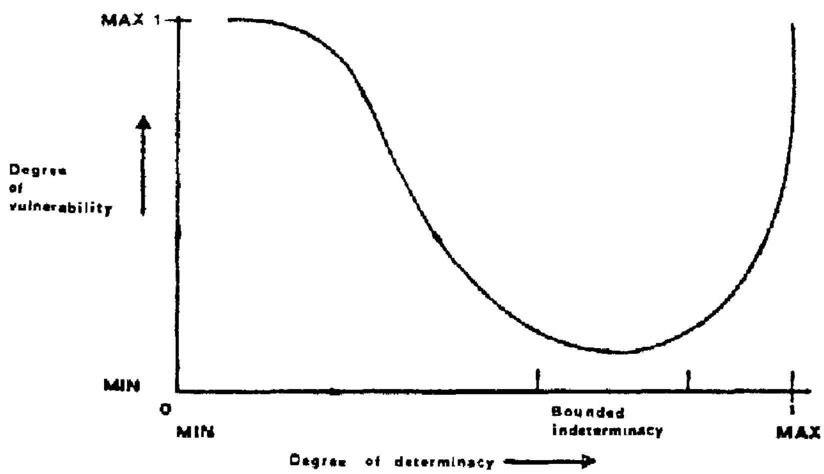


Figure 4

Hypothetical Relationship Between
Vulnerability and Indeterminacy

FOOTNOTES

1. Funds for this work were provided partly by the Italian National Research Council, and its assistance is appreciated, but responsibility for the content is solely that of the author. This paper was written while the author was a visiting professor at the Disaster Research Center, The Ohio State University. Professor E.L. Quarantèlli, the Center's Director, is thanked for his help and for the advice he offered on preliminary drafts of the paper. The author is also very appreciative of the fine work by Ruth Orr in typing the draft and the final version of the paper.

2. Four years after the impact, less than 50% of the houses have been rebuilt, while about 40,000 disaster victims still live in a temporary housing system. The disaster area communities show differential trends. Those already developing in the pre-impact period have had an acceleration of their economic and urban improvement dynamics, while those already marginalized (e.g., mountain communities) have tended to increase their degeneration or to maintain a steady under-developed state. For the sociologically relevant history of the Friuli earthquake, see Geipel [1977], Strassoldo and Cattarinussi [1978], M. Strassoldo, [1979], Tellia [1979].

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