Research & development

Risk perception versus seismic risk: An introduction

A seismic event generally has consequences on the social relationships, economy and culture of the impacted territory. As Mary Douglas quotes, a change into the social perception of risk as consequence of an earthquake may have effects on the lifestyle of the local community.
The above mentioned statement is the starting point of this article. Illustrating the difference between peril and risk is the second point. According to the Aristotelian theory of categories, risk can be considered as a human characteristic depending on social and cultural factors. Risk is here intended as a social category and cannot be de facto reported as a statistical or stochastic function based on a mathematical formula, as long assumed in the past. This approach, then, requires a deep revision.
In this sense, and following the concept of risk perception, seismic risk is analysed in this article in terms of impacts, precautionary measures, risk assessment and management.
Knowledge of this topic cannot be intended as a simple philosophical exercise, since right on awareness depend risk reduction, humans and goods too

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F. Cubeddu

Risk definition and risk perception versus seismic risk

Risk consists in the probability of an unfortunate event multiplied by the size of its consequences in time.
The Webster's Third New International Dictionary, in fact, defines risk as *the possibility of loss, injury, disadvantage, or destruction: contingency, peril, danger, threat (the infinite care and ~ which are involved in the dangerous mission of bomb disposal) (foreign ships and planes refused to run the ~ of attack)*.
Risk, as a probabilistic measure of future adverse effects, cannot be regarded as a property or characteristic of an object, since: (i) there is no social definition of "harmful or beneficial effects"; (ii) there is no agreement of how to aggregate different adverse effects into one; (iii) secondary effects delayed in time may occur as a consequence of a primary loss and they have to be taken into account.
Thus the technical concept of risk looks at society as an "amorphous body" in which values and expectations are not different. The lack of social context in the technical definition of risk has been noted by many social scientists and also by many engineers who manage risk assessment (R.B. Cumming, 1981). There is a need to integrate the technical analysis of risk with cultural, social and individual responses, because risk events interact with these processes and determine public reactions.
On the other hand, we can affirm that public reaction to risk is in the spirit of modern democracies. In fact, the political class must take into account public opinion also in the case of opposition to the decision process. We can affirm, following Voltaire, that the possibility to express disagreement is the essence of democracy.
This matter is engaging many institutions (academia,

Contact person: Francesca Cubeddu
francesca89cubeddu@gmail.com

experts, bureaucracies, etc.) and is giving new intellectual stimulus to help society to find out a new way of living together with risks. These problems have been faced by the governments of industrialized societies in the last 20-30 years. Their presence carries a confrontation between policies of development on the one side and of environmental safety, security and quality of life, on the other.
From the viewpoint of social science, the concept of risk contains a large part of uncertainty depending on its perception, management and communication.
"Risk estimates are uncertain, are described in technical language, and are outside the general understanding or experience of most people. Perception plays a crucial role, tending to exaggerate the significance, for example, of risks that are involuntary, catastrophic, or newsworthy" (McGraw-Hill Encyclopedia of Science &Technology, 2001).
In conclusion we can affirm that:

1. Perception of risk depends on the information people are exposed to, and it is therefore important to know the information that people have, that they choose to believe, and their degree of confidence in involved stakeholders as well as institutions, media and private opinion groups
2. The way of communicating these information is decisive in order to obtain greater awareness on energy, environment and technology
3. The risk becomes a "social construct" and we will assume this definition also for seismic events
4. *"Effective risk management therefore requires effective risk communication"* (see next paragraph; McGraw-Hill Encyclopedia of Science &Technology, pg. 505, volume 15).

Also the seismic risk is calculated with a formula of the algebraic product of local seismic hazard, seismic vulnerability and exposure:

R (risk) = L (local seismic hazard) * V (seismic vulnerability) * E (exposure)

Perception of risk is a very important and complex concept. It depends on the cultural and social dimensions of different social groups. That is why there does not exist any vision of risk that changes based on historical age and territorial dimension. In fact, if we ask to different social actors, in different situations and different periods, a comment on their risk perception, we will obtain different answers. Smoke, for example, is considered very dangerous today, more than 40 years ago. Another important factor is the subject of the question: answers depend on the involved persons, i.e., an expert, a politician, or a member of public at large.
Risk is considered by M.W Merkhofer, (1987), as part of an analytical - decisional schema that includes responsibility for management of technological risk, taking into account the following four connected statements (here summarised):

1. The presence of a risk source that includes perils
2. The presence of an exposure that includes a relationship between risk and the individual
3. The presence of adverse effects due to the exposure
4. The presence of an individual and social evaluation about the importance, severity and iniquity of impacts.

The first three propositions concern the engineers' approach to the risk, which is based on the belief that the classification of risks includes the possibility for better safeguard and better decision support. The fourth statement emphasises the social acceptability of risk based on different belief, perception and a different associated importance. People have these "imperfect perceptions" because of different mental, cultural and value schemas present inside a societal body where everyone has a different mode of considering the same event.
Paul Slovic (2000), one of most important scientist on risk perception, affirms that social risk perception depends on mental, political, social, cultural patterns relevant in order to take political decisions on risk. According to Slovic, also risk voluntariness, control, possibility of catastrophes, equity and future generation damage must be considered into the political decision-making.
There is a substantial difference between information and communication inside risk studies. Nevertheless these words are used, also by experts, as synonymous. Generally speaking, the term information indicates an activity useful to transmit data from a subject to

others in order to provide knowledge on a certain topic.

"In popular usage the term information refers to facts and opinions provided and received during the course of daily life: one obtains information directly from other living beings, from mass media, from electronic data banks, and from all sorts of observable phenomena in the surrounding environment. As a person uses such facts and opinions, he generates information of his own, some of which is communicated to others during discourse, by instructions, in letters and documents, and through other media. Information organized according to some logical relationships is referred to as a body of knowledge, to be acquired by systematic exposure or study (The New Encyclopaedia Britannica, 2001).

Information is *de facto* a unidirectional process in which we may distinguish two or more actors: one has a certain number of data to transmit to others, who accept or refuse the information. There is no contact between the two parts.

In the term communication a set of social actions are embedded which involve a relationship among "partners".

"Communication, the exchange of meanings between individuals through a common system of symbols, concerned scholars since the time of ancient Greece. Until modern times, however, the topic was usually subsumed under other disciplines and taken for granted as a natural process inherent to each. In 1928 the English literary critic and author L.A. Richards offered one of the first - and in some ways still the best - definitions of communication as a discrete aspect of human enterprise: Communication takes place when one mind so acts upon its environment that another mind is influenced, and in that other mind an experience occurs which is like the experience in the first mind, and is caused in part by that experience" (The New Encyclopaedia Britannica, pg. 623, volume 16).

The concepts of perception, information and communication of risk are useful to introduce the risk related to seismic events. In fact, the above mentioned definitions can be used, in theory, for environmental and technological risk perception, too, taking into account the differences in local situations. For example, same methodologies and approaches have be used in the past for assessing the perception of risk in the field of desertification or of nuclear fusion. In any case, exchange of information and organisation of a communication process are crucial to creating the necessary awareness.

In case of a seismic event, exchange of information occurs among disaster experts and citizens. Because of its environmental nature, generally seismic risk communication is taken into account only in the presence of the event. For a large part of population living in seismic areas we can speak of a conscious acceptability of the risk that includes the potential economic, social and environmental damage, according to the following formula mentioned before:

R (risk) = L (local seismic hazard) * V (seismic vulnerability) * E (exposure)

where L is equal to site hazard, i.e. the measure of the attended seismic event in the specific site during a specific period of time.

Local seismic hazard is a characteristic of the territory non-dependent on the presence of population or goods. Local seismic hazard is evaluated based on historical and morphological characteristics. We can speak of two different categories of hazard: direct and indirect. The former depends on the probability of the seismic event in the area whereas the latter depends on the consequences (i.e. mudslides, landslides and soil liquefaction) that may be activated by an earthquake. Three indicators define seismic hazard in a probabilistic way:

1. *Historical*: it describes the characteristics of past events, their effects and the damage they caused. Information sources are seismic catalogues, earthquake stations, victims' census, caused injuries and, if possible, testimonies;
2. *Seismological*: it defines probable epicentres via the good knowledge of active faults and geotechnical properties of the impacted land;
3. *Geological*: it identifies the sites where seismic occurrence is frequent or "depressed".

The first and the second indicator are useful to build up macro-zoning, the third is useful for the evaluation of local risk and micro-zoning.

There is a fundamental difference between risk and peril, as mentioned above. Local seismic hazard (L), becomes risk when the seism can cause damage to persons and buildings. We speak of a peril when considering the seismic event and its consequences independently of the presence of humans and human artefacts.
Letter V of the formula indicates the seismic vulnerability of a structure and its probability to have a damage as a consequence of the seismic event. We can define vulnerability in the following way:

1. Direct vulnerability, connected to a single structure
2. Induced vulnerability, connected to the measure of negative impact on the territory and its infrastructures
3. Deferred vulnerability, which indicates the ratio between subsequent injuries due to the event and the first emergency taking into account the community behaviour.

In general, the vulnerability of buildings is represented by their attitude to suffer damage due to a seismic event considering their own structure characteristics. The vulnerability of a whole territory (i.e., a town, a Province, a Region) is represented by its attitude to suffer damage due to a seismic event taking into account its morphological and geological characteristics. The vulnerability of "man" is represented by the human nature, individual and social perception of risk, knowledge of the possible risks, possibility to receive information about them, possibility to manage them, presence or absence of emergency plans and preventive information. Hence, we can affirm that area vulnerability is strictly connected to population presence, demographic aspects and geological characteristics.
Letter E of the formula indicates the Exposure and is connected to the land use, i.e. distribution, house density, presence of infrastructure and its use, economic value of goods and, last but not least, value of human life. Considering all these factors, it is possible to hypothesize seismic risk reduction in the following way:

1. by localising new buildings in low-risk areas, reducing the induced vulnerability
2. by adjusting the pre-existing patrimony, and
3. by using a safer construction model.

Conclusion

The discussion on risk perception and risk communication is an important step also when it comes to communication related to seismic events. Also in industrial or environmental disasters such as, for example, Seveso's and Ilva (Taranto), the following aims must be taken into account:

1. the territorial articulation of the protection agency with the local community is indispensable in order to obtain the protection of the diffuse social interests
2. creating strategies for an active presence in the management of risk may be a decisive factor in order to minimise the negative effects of the seism
3. to design a first characterization of the contexts where the negative event has taken place, in order to know how the public administration and the local society have managed their territory and environment
4. to foster a deeper study of the local systems in order to single out the elements of the formation and dynamics of the local social preference on risk perception
5. do not consider in advance the possible local conflict as a negative or troublesome fact, but rather as an opportunity for its content of new knowledge, opportunity and learning: conflict and the social dialects are "democracy at work"
6. do not take for granted the territorially-competent public instruction (Region, Province, Municipality, Mountain community, and the State peripheral organs) as an exclusive representative of local interests, even if it is to be considered as a privileged interlocutor
7. to take into account that when a seismic event breaks into the local scene, it influences the relations among the various territorial governmental institutions, generating an institutional impact that ought to be managed

8. to provide communication based on a democratic model that includes a wider and wholly bidirectional communication. In order to achieve this, two conditions must be present: the precise intention of the transmitter to confront himself with the public (providing and acquiring knowledge as well), and ability and willingness by the public to evaluate the information for acceptance or refusal.

Francesca Cubeddu
Master degree in Sociology, Applied Social Science, "Sapienza" University of Rome. The thesis has been developed in ENEA, tutors Gaetano Borrelli and Paolo Clemente

references

- G. Bongiovanni, P. Clemente, M. Forni, S. Hailemikael, G. Martini, A. Paciello, D. Rinaldis, V. Verrubbi, A. Zini (2013), "Valutazione della pericolosità sismica: considerazioni", *Energia Ambiente Innovazione*, 3-4/2013:2-9, ENEA, Roma
- G. Borrelli, S. Sartori (1990), "Rischio tecnologico e interessi diffusi", *Quaderni Studi ENEA*, ENEA, Roma
- R.B. Cumming (1981), "Is Risk Assessment A Science?", *Risk Analysis*, Volume 1: 1–3
- M. Douglas (1985), "Risk acceptability according to the social sciences", Russal Sage Foundation, New York
- Tokyo Metropolitan Government (2010), "Earthquake Survival Manual", Shinjuku-ku, Tokyo 163-8001
- S. Ikeda (1986), "Managing Technological and Environmental Risks in Japan", *Risk Analysis*, 6: 389–401
- E.R. Kasperson (1986), "Six Propositions in Public Participation and their Relevance for Risk Communication", *Risk Analysis*, 6:275-281
- R.E. Kasperson, (Editor) (1991), "Communicating risks to the public", Kluver Academic Publisher, the Netherlands
- McGraw-Hill Encyclopaedia of Science & Technology (2001), volume 15, pag.505, United Kingdom
- Merkhofer M.W., (1987), *Decision Science and Social Risk Management*, T. Reidel Publishing Company, Boston
- Slovic P., (2000), *The perception of risk*, London and Sterling, Earthscan Publication
- The New Encyclopaedia Britannica (2001), volume 16 pag. 623 e volume 21 pag. 617
- Webster's Third New International Dictionary (2001)
- A.M. Weinberg (1981), "Reflections on Risk Assessment", *Risk Analysis*, volume 1: 5–7