Reducing natural risk: regional and urban strategies for resilient planning

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Theme:
Austerity (Risk and Resilience)

Introduction

Even if the estimated economic losses from natural disasters (an event that occur naturally, but which can have negative consequences for people and environment) in 2014 (US$ 99.2 billion) was the fourth lowest since 2004 with 140.7 million of victims and with the death of 7.823 people, the data reduction is not as fast as expected (Guha-Sapir et al., 2015). The implementation of preventive measures (proactive policies instead of reactive policies) (Godschalck et al., 1999) remains difficult to achieve: high construction costs, indefinite timelines for jobs, widespread low sensitivity to environmental risks and limited subjective perception of the risk, limit the action of government institutions especially at the local scale (Dolce, 2012).

In Italy, the occurrence of extreme events, such as L'Aquila's earthquake in 2009, the Emilia Romagna region's earthquake in 2012 and the flood in Liguria region and Genova in 2014, determine a significant implementation of post-event municipality policies, construction's codes and laws.

Since that urban planning is an important instrument for increasing resilience, reducing losses following natural disasters, developing management for sustainable hazards mitigation (Burby et al. 2000), it is necessary to create guidelines for trans-scalar multidisciplinary strategic urban planning that allow the city to respond to the needs in short term underling the importance of advanced planning strategies

Authors present a methodology that can help to reduce risks related to natural hazards, acting on consolidated urban fabric through long-term reuse, renewal and regeneration prevention actions.

Risk as individual and societal feature

The field of risk assessment is rapidly growing with contributors from many areas of the natural and social sciences (engineering, economics, political science, sociology, psychology, and philosophy). Some theorists have grouped these perspectives, dividing them into several categories. The risk approach considered in the paper is the scientist approach (statistical and probabilistic approach): risk is something that can be measured in a systematic way by employing the scientific method (Renn, 1992). Furthermore, risk can also be defined as "Expected losses due to a particular hazard for a given area and reference period. Based on mathematical calculations, risk is the product of hazard and vulnerability" (UNDHA, 1992). So, the main characteristics of risk are: hazard, vulnerability, exposure and adaptation.

Among all the different definitions:

- Hazard is "a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation" (UNISDR, 2004);
- Vulnerability is "the degree to which a system acts adversely to the occurrence of a hazardous event. The degree and quality of the adverse reaction are conditioned by a system's resilience" (Timmerman, 1981; UNDRO, 1982; Susman et al., 1983);
- Exposure is the "Presence of people, livelihoods, environmental sources, infrastructures and activities (economic, social and cultural) in places where they could be adversely affected by physical events and thus subjected to a potential future damage or loss" (Crichton, 2002 Gasper, 2010);
- Adaptatability is "The ability of an individual, family, community, or other social group to adjust to changes to environment survival and sustainability" (Lavell, 1999).

It is interesting its distinction between Individual Risk and Societal risk (Jonkaman, 2003). While the former is a feature of the place and it is defined as the probability that an individual remains affected due to dangerous activity (or hazardous event), the latter is the relationship between the frequency of occurrence and the number of people that can remain affected by a hazardous event within an area independently of the precise localization.

Many authors (Jonkman, 2003; Laheij, 2000; Piers, 1998) starting from the explanation of Societal risk, define the parameter E (N), Expected Value of Victims that links the Individual Risk and the population density in a given area. Since human beings are the key elements exposed to a risk, the assessment of the exposure of the different urban functions (residential, commercial, tertiary buildings, industrial, critical facilities, social and economic infrastructures) is crucial for disaster risk reduction. Societal Risk can describe more precisely the dynamics of cities related to the behavior of people as dynamic entity (localization, distribution, density, individual characteristics, day and night behavior): it allows to quantify the exposure at macro-scale (regional and municipality level) and widespread micro-scale (neighborhoods and single blocks).

Scale's change (from macro to micro) and more precise localizations bring back the Societal Risk to the Individual Risk: even a single building can fit with Individual Risk's definition. Since that, it is a "container" of functions and therefore of people, it is the ideal "area" in which calculate Societal Risk of a group of individuals connected to the same function in a significant urban scale.

So, the Individual Risk can be directly connected to single person and to single building and the Societal Risk needs a group of people and a building. In a mere urban level, the central element to analyze is the building and then the block.

Furthermore, here, the risk's key component is vulnerability: buildings (or blocks) may suffer significant damages but can be resistant enough to support the effects based on its intrinsic characteristics.

The flexible vision of Societal and Individual Risk allows embracing the problem of risk's explanation from different point of views but it is clear the difficulty to give precise definitions and mathematical formulations.

Vulnerability and Exposure evaluation

One of the main aspects to define seismic risk and, therefore, to make prevention activities is the identification and evaluation of all the aspects that constitute Vulnerability and Exposure. It is interesting the methodological approach developed by Project SAVE (INGV and GNDT, 2002): here, vulnerability is mainly linked to probability of damage caused by earthquakes; instead, exposure is referred to buildings and people. The latter (defined Casualties) derives from ISTAT (National Institute of Statistics) census' surveys and the amount of collapsed buildings. The data related to population, however, concern only the residents and therefore only residential function.

Many studies focus on historical centers: one of the main characteristics of European old town is definitely the presence of buildings with functional mix: in a single block, private residences, shops, offices and facilities coexist. These functions attract a huge number of people and present very different hours of use: it is necessary a more detailed explanation of urban dynamics to define a more precise Exposure and Vulnerability Indexes related to different functions and for specific periods (daily and annual).

Methodology

The presented methodology is applied to an ideal historical settlement consistent with the European reality: city's pattern is structured with several blocks divided by population density (and morphological structure of turban fabric) and characterized by functional mix. In the hypothesis that the territory has the same degree of hazard, to calculate the Exposure Index (average, maximum, daily or annual) of each urban function authors consider:

- Gross Floor Area (GFA) of a specific function compared to the total GFA of the entire city;
- Number of persons present in that function, compared to all the residents of the city;
- Number of hours per day in which that function is used.

In order to calculate Vulnerability Index (average, maximum, daily or annual) of each urban function, authors consider:

- Number of people that, in a given period, occupy the function;
- Number of hours of function's use;
- Different age of the people present in that function.

The distinction by age group (Peek-Asa et al, 2003) allows defining a correction factor, IIF (Body of Liability Index). It is based on the age of the population and the possibility that, according to it, a person does not get hurt (i.e. to be able to reach safety) during a hazardous event: the index, obtained through a pairwise comparison, describes elderly and children as the weakest part of population.

Urban planning strategies

The determination of specific Risk Indices for each block is a starting point to enhance ex-ante interventions and to create city-wide advanced planning strategies. Among them, permanent relocation can be an

important management tool useful for enhancing residents' hazard vulnerability in floodplains, earthquake prone areas, landslide areas and as a hazard mitigation measure with natural or technological threats.
Two possible intervention in the city (from urban scale to regional scale) to reduce risks are:

- **Areal change**: relocation of a specific urban function from high-risk to low-risk area. It acts directly on the physical relocation of different buildings in areas less dangerous: the function keeps unchanged and the planner/designer only defines the use of the abandoned building that should have a lower exposure;
- **Functional change**: replacement of high exposure functions with lower exposure ones in the same area. It acts on the function by reducing exposure that implies consequently a reduction of natural risk and physical and economic losses. It is possible to carry out the intervention taking into account the level of compatibility between different uses.

Conclusions

Areal Change involves significant modifications of inner structural organization and their relations of cities.
The relocation often involves land use (especially when there are no suitable area to reuse and restore): it is possible create specific policies to allow the new use of land only if the risk reduction (of the specific function that is relocated) is consistent. Obviously it must be sought the scenario with the minimum wastage of soil and the most improvement of the risk reduction.
To ensure urban regeneration processes based on the Functional Change, it can be created a specific urban policy (technical, related to land-use and laws) focused on flexibility of each function in in relation to buildings and blocks.
In both the presented strategies, it is possible recognize high costs: public support activities (information, advice); buildings acquisition; disused buildings demolition; re-naturalization of abandoned areas; maintenance to make the building usable according to new uses; compensations for loss of environmental quality in resettlement sites; social (the anthropological value of the assets) and private costs.
Another critical issue in the implementation of these policies is the highly fragmented system of private property: the ability to transfer volumes (Areal Change) and functions (Functional Change) can collide with the difficulty of owners' acceptance.
As future steps, it is necessary to study some concrete applications of relocation, already happened especially in US, in order to define the most suitable ways for implementation and to define more extensive and accurate exposure mapping of the settlements. In this way, the definition of real social and economic feasibility of relocation is possible.

Notes

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