Innovative methods on territorial vulnerability study for the preparation of emergency plans

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Highlights

The natural events lead to a high level of urban vulnerability which reduces the safety of the inhabitants and determines the crisis of the functioning of strategic sectors. Construction determines a constant hazard independently from the event. The experimental analysis method proposes the study of building features and adoption of urban policy tools that reduce the vulnerability. The instrument has been adopted by the municipality of Pozzuoli in the field of drafting of Municipal Emergency Plan.

Abstract

In recent years, we have witnessed natural events that have had impressive effects on the city and its inhabitants, highlighting a great vulnerability of the territories. In this context, the National Civil Protection has forced local administrations to adopt an Emergency Plan based on risk analysis. The proposed contribution illustrates the application of an innovative methodology that focuses, for the estimation of the vulnerability, on the urban / construction analysis and the operation of emergency health care facilities.

Keywords

Vulnerability, Urban settlements, Natural Hazards, Civil Protection, Healthcare Emergency

1. INTRODUCTION

The research stems from a consideration about the “spontaneous” development of urban settlements: there is no doubt that in the absence of complex analysis, originally populations have gradually occupied the parts of the territory that proved safer and that building development in terms of materials and construction techniques was oriented towards types that had shown their effectiveness in time. Then the use of “artificial” ultra-resistant materials and the development of complex construction techniques has enabled the urbanization of parts of the territory that were traditionally considered “dangerous”: urban development, governed by planning tools, started to disregard natural hazards. At that juncture, the geomorphological layout was changed, and the memory of the events was lost: nature has adapted to the

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manmade modifications finding new forms of balance. Evidently, the changes procured have exceeded the maximum limit of energy redistribution; the reason why in recent years we have witnessed natural events that have had impressive effects on the city and its inhabitants, highlighting a very high vulnerability of the territories and the inability of local administrations to organize the immediate emergency and rescue actions. Modern metropolitan urban systems have developed following urban plans that have not “sufficiently” considered environmental hazards, allowing the urbanization of critically endangered areas and the location of strategic and rescue buildings in unsuitable areas. In this consolidated context, the National Civil Protection has forced local administrations to adopt an emergency plan that, based on risk analysis, define the procedures necessary to manage emergencies, to safeguard lives and ensure the disaster relief functions.

The Campania Region is certainly one of the most exposed to “natural” risks, because of particular territorial geomorphological features and of the indiscriminate human settlement of the area. The presence of the active volcanic systems of Vesuvius and Campi Flegrei, the high degree of seismic activity underground and diffuse hydrogeological conditions involving most of the slopes and the main waterways, have created the real hazard conditions for the population that, accustomed to living with these risks, do not perceive the danger.

The atavistic underestimation of territorial vulnerability by municipal and regional urban planning, has determined an increase of settlement loads in the Vesuvian and Phlegrean areas both in inland (Sarnese ......) and coastal areas.

Figure 1. From the top clockwise: Flood in Atrani (Sa) 2010 – Flood in Giampilieri (Me) 2009 – Eruption of Etna (Ct)- Earthquake of Aquila (2009).
In addition, the failure to control the territory and the widespread phenomenon of unauthorized construction, also triggered by urban policies characterized only by an incomprehensible and anachronistic denial, led to the formation of large urban settlements not structured to respond to crisis situations.

In this scenario the region of Campania has strongly implemented a policy to inform the public and to promote the preparation of emergency instruments, to allow local administrations at least to analyse the risk scenarios and plan for emergency actions, through the preparation of the Guidelines on drafting of the Municipal Emergency Plans, in which the minimum content of the analysis and emergency implementation instruments is defined, in line with the national regulatory framework.

Simultaneously a debate on “Territorial Resilience” developed that allows us to combine the peoples housing need with a territory subject to a number of dangers, in fact expanding the value of the Emergency Plan from an emergency organization tool to address document for a new urban planning.

On the basis of these considerations and pursuant to the additional value attributed to the Plan, we are developing an applied research in the assessment of risk scenarios to support the preparation of the Emergency Plan of the municipality of Pozzuoli, conducted by the Department of Civil Construction and Environmental Engineering of the University of Naples Federico II, that will complement the traditional areas of vulnerability analyses with the new issues related to urban dynamics and building from which to draw considerations relevant to the implementation of the contents of the Plans, and to create a dynamic tool to update the building census, to control and plan land use.

Simultaneously preliminary considerations developed about the research in progress on the issues of the response that the health system has to offer, during emergencies to respond adequately to a “Mass Casualty Event”.

In fact, despite the fundamental importance of the function of hospitals in the emergency system, there is a surprising lack of research in the field of spatial and infrastructure planning in health care services that guarantees operation in crisis situations, in the field of “surge capacity “ and the preparation of Emergency Plans for Massive Influx of wounded (Piani di Emergenza Interni per Massiccio Afflusso di Feriti P.E.I.M.A.F) of hospitals that on several occasions have proved to be part of the problem and not part of the solution.

2. STATE OF THE ART

The preparation of the Plans is part of the national legal context defined by
The objectives are to identify the conditions to ensure the health emergency acceptance of a contemporary high number of patients. The Municipal Emergency Plan is divided into three main levels: General part: to acquire all information related to local knowledge and monitoring networks in order to process the possible loss scenarios. Outlines of planning: to identify the objectives to be achieved to organize an adequate civil protection response to the occurrence of the event and to indicate the Components and the Operating Structures. Intervention model: that allows the procedural organization of the interventions that the components and the Operating Structures of Civil Defence identified in the Plan implement should the event occur. The risk analysis provided by the guidelines relate to: Hydrological risk: characterized by flooding, landslides and hazardous weather events of high intensity and short duration, with particular reference to hydraulic risk and landslide risk Seismic Risk: determined by a combination of hazard, vulnerability and exposure, it is the extent of the damage expected in a given time interval, according to the type of seismicity, the resistance of buildings and of human settlement. Volcanic risk: defined as the product of the probability of occurrence of an eruptive event for the damage that might result. Fire risk of forest fires and interface: defined by the prediction of potential fire scenarios with origin in the vicinity of the areas of interconnection between human structures and natural areas. Industrial risk: defined by the analysis of the dangers of the industrial activities taking place in the vicinity of urban areas. Regarding hospitals, the national legislation concerning the maxi-emergency management originated in 1996, with the enactment of the “General Criteria for the Organization of Relief in the event of disasters” prepared by the working groups appointed by the Cabinet. The guidelines on the health emergency system 1/96, pursuant to DPR 27 / 03/92 on “Emergency System Urgency” in relation to Maxi emergencies, identify measures for the internal organization of hospitals and emergency rely on the personal care of the Department of Emergency and acceptance (DEA) also the preparation of plans for the acceptance of a contemporary high number of patience. The objectives are to identify the conditions to ensure the health emergency activities evenly throughout the national territory; provide guidance on ...
organizational and functional requirements of the emergency network. The proper management of complex events requires the cooperation of all the departments responsible for health emergency through the organized and direct connections along precise lines of fixed responsibility.

3. METHODOLOGY

As it is obvious, the risk scenarios are related to the occurrence of a particular event and the impact that this produces on the urban reference area, both in terms of building volumes and of the population involved; it is therefore essential to make a careful urban reference area analysis in this case it is the municipality of Pozzuoli.

The most advanced tools to determine seismic vulnerability, in the field of civil protection, propose to develop the analysis as described in the Manual for the compilation of the first level tab for the typological - structural characterization of urban sectors that consist of ordinary buildings “CARTIS 2014 “developed with the Project Reluis 2014-2016 Line “ Development of a systematic methodology for the assessment of a regional scale on the basis of typological and structural characteristics of the buildings. “

In the specific case, having the ability to interface the data collected with...
the procedures codified in the field of seismic vulnerability, it was decided to initiate, in parallel, an applied experimentation, addressed exclusively to the technological elements and finishing of residential buildings, their maintenance and the relationship between building volumes, and exit routes which, not only affect transversely on the determination of all risk scenarios, but individually determine a level of danger that is often the most common on urban territories [detachment of the frames, cornices, tiles, plaster and coatings ... ...]. The purpose of the research is to assess the “building vulnerability”, by direct analysis of the buildings and the urban environment, and propose a summary

![Figure 3. Pozzuoli – Building type form for the sub-Area.](image)
sheet, to enable the assessment of the danger and guide the choices of the designer of the Emergency Plan.

At the outset, an analysis of the historical evolution of the city was developed, remembering the major events that happened (Earthquake of 1980 and the long period of the still ongoing bradyseism), basis on which “historical” macro areas have been defined; The data was then intersected with the delimitation of census areas, for which statistical information is available, for the definition of the Areas. Within the Areas a study was carried out, through direct surveys, to define homogeneous building types, according to their definition of the “subsectors” classified with a nomenclature consistent with Cartis form. For each sub-Area “the building type” was analysed according to the approach of UNI 8290 - Classification and decomposition of the building system - paying attention exclusively on the first three Technology Unit Classes: Structure - closure - Internal Partition.

The form concludes with an evaluation of the critical elements to which, by means of a weighting coefficient system [being tested], a numerical value is assigned which is then incremented by certain multipliers of urban risk. The determination of the Construction Vulnerability parameter translated into chromatic terms and reported on the municipal mapping, allows a clear indication of the danger connected to the intrinsic characteristics of the building system and guides the designer choices from the Emergency Plan.

4. THE MANAGEMENT OF THE HEALTHCARE EMERGENCY

At the same time regarding the healthcare emergency, the research started from the premise that disasters, both natural and technological, can create a big influx of wounded that can go beyond the capacity of the urban infrastructure systems and internal management of emergencies. These events are called internationally “Mass Casualty Event”, i.e. a situation in which the health care system loses the ability to handle the influx of patients. To reply to a “Mass Casualty Event”, the emergency management system and in particular the health care system must have an adequate “Surge Capacity”, which is the ability of the health system to handle a sudden influx of patients; this capacity ‘depends on a well-organized incident management system, and from further variables such as: available space, resources, medical personnel and special strategies, as in the case of contaminated and infectious patients. In practice, “Surge Capacity” is obtained based on empirical approaches that are not based on substantial “evidence” and therefore called “obscure” (5).

The “National Preparedness Guidelines”, published by the “Department of

una sperimentazione applicata, rivolta esclusivamente agli elementi tecnologici e di finitura dei fabbricati residenziali, alla loro manutenzione ed al rapporto tra i volumi edilizi e le vie di esodo che, oltre che incidere trasversalmente sulla determinazione di tutti gli scenari di rischio, determinano individualmente un grado di pericolo che spesso risulta il più diffuso sui territori urbani [distacco delle cornici, dei cornicioni, delle segole, degli intonaci e dei rivestimenti...].

La finalità della ricerca condotta è di valutare la “vulnerabilità edilizia”, mediante un’analisi diretta degli edifici e del contesto urbano, e proporre una scheda di sintesi che, consentendo di individuare gli orti di vulnerabilità, di definire le “zone di azione” e di orientare le scelte del progettista del Piano diEmergenza. In via preliminare si è sviluppata un’analisi dell’evoluzione storica della Città, anche in considerazione dei principali eventi accaduti (Terremoto del 1980 ed il lungo periodo del bradisismo tutt’ora in corso), sulla scorta della quale sono state definiti macro aree “storiche”: il dato è stato successivamente intersecato con la perimetrazione delle zone censuarie, per le quali si hanno le informazioni statistiche, per la definizione dei Comparti. All’interno dei Comparti è stato effettuato uno studio, mediante sopralluoghi diretti, per definire le tipologie edilizie omogenee, in base alle quali sono stati definiti i “Sottocomparti” classificati con una nomenclatura coerente con le schede Cartis.

Per ogni Sottocomparto è stato analizzato “l’edificio tipo” secondo l’approccio della Norma UNI 8290 - Classificazione e scomposizione del sistema edilizio - ponendo l’attenzione esclusivamente sulle prime tre classi di Unità Tecnologica: Struttura – Chiatura – Partizione Interna. La scheda si conclude con una valutazione degli elementi critici a cui, mediante un sistema di coefficienti ponderali [in via di sperimentazione], viene associato un valore numerico che successivamente viene incrementato mediante alcuni coefficienti moltiplicativi determinati dalle condizioni di rischio urbano. La determinazione del parametro di Vulnerabilità Edilizia tradotto in termini cromatici e riportato sulla cartografia comunale, consente di ottenere una chiara indicazione sul pericolo connesso alle caratteristiche intrinseche del sistema edilizio ed orientare le scelte del progettista del Piano diEmergenza.

4. LA GESTIONE DELL’EMERGENZA SANITARIA

Contextualmente per quanto attiene l’emergenza sanitaria si è partiti dalla considerazione che gli eventi calamitosi sia naturali, sia tecnologici, possono generare un mass-afflusso di ferti capace di mettere in crisi i sistemi infrastrutturali urbani e di gestione interna delle emergenze. Tali eventi a livello internazionale sono definiti “Mass Casualty Event”, ovvero una situazione nella quale il sistema sanitario perde la capacità di gestire l’afflusso di pazienti. Per rispondere a un “Mass Casualty Event”, il sistema di gestione delle emergenze ed in
American Homeland Security” in 2007, indicate the “Surge Capacity” as one of the basic resources (skills, results, measures) that the nation must implement to be ready to face a disaster. The parameter that has been identified for the solution of the problem is the hospital bed; in reality, the problem is finding various resources, such as stocks of materials, equipment, physical facilities and medical personnel (doctors, nurses, staff for psychiatric support, technicians). In Italy, the concept of the “Surge Capacity” is not well defined. In the guidelines, “Adoption of the maximum Criteria for the organization of healthcare disaster relief”, generically states that the Central 118, in conjunction with local services of AA.SS.LL. (Department of prevention etc.) have the task of defining the number and capabilities of hospitals, without specifying what those capabilities are.

The performance of the health service in the event of MCE depends on the medical management of three macro areas: the pre-hospital, hospital and the union of these two areas through an efficient patient transport system. The pre-hospital area includes the management of the accident site, while the hospital area provides for the reception and treatment of numerous patients in a very short period. The success of medical management during MCE depends on the rational use of resources that will ensure the timely provision of the best treatment for a large number of people.

The hospital department where this need is more compelling is the Emergency Department or Emergency Room, as it plays a vital role in disaster response, representing the link between the pre-hospital response and hospital resources. In Italy as in other countries, we begin to recognize the role of D.E.A. in the management of M.C.E. In fact, in 2007 the SIMEU (Italian Emergency-Urgency Medicine Society) in “the SIMEU Program for the construction of the Integrated Territory-Hospital System for Emergency-Urgency”, states that the Emergency Room, intended as operating and organizational places common at all operating levels, where the early stages of emergency operations are undertaken, must be equipped with areas for the decontamination and the maxi emergency, to cope with a massive influx of patients as a result of various accident types.

The international recognition of the role of healthcare facilities in the management of these emergencies is demonstrated by the growing number of countries that require that their hospitals be provided with plans for disaster management: “Disaster Plan” in the United States and Australia, “Business Continuity Plan” in the UK, Internal Emergency Plan for Massive Influx of wounded (PEIMAF) in Italy. The World Health Organization (WHO) in the guide published in 2007 “Mass Casualty Management systems: Strategies
and guidelines for health sector capacity building”, recognizes that one of the main players in the case of “Mass Casualty Event” are hospitals themselves, and suggests the need to also develop hospital-wide plans indicating how to handle the “Mass Casualty Event”. These plans should be consistent with national standards, and include all items on the planning, response and recovery and should define roles and responsibilities for all sections of the structure in a “whole-of-health” approach. The instrument drawn up by the Italian regulation for the management of the management of the maxi-emergencies inside hospitals is the Massive Influx of Wounded Plan. The strategy of P.E.I.M.A.F. to provide proper treatment to the many victims who come to the hospital from the scene (without reducing the health support to patients already hospitalized), conceives for the organization of the hospital, in terms of space and resources, the training of its staff, with the allocation a specific task to each to be performed in case of emergency.

5. CONCLUSIONS

The experiment conducted thus far has added an important element to the assessment of territorial vulnerability, adding reflections on the building system that is often the main cause of danger, which is amplified, in the presence of various risk scenarios. The future development of the research will be focused on the particularization of the data collection form and the weighting of the numerical coefficients through interactive simulations and comparison with the different risk scenarios.

A proposal will be put forth to the local administration to make the completion of the data form compulsory for all buildings in order to obtain an accurate database and to be able to work on real and not typologically mediated data, as well as the possibility to have the ability to update the emergency plan content.

Regarding the hospital building research it will be implemented analysing both the Hospital- Territory relationship, and the internal hospital organization aimed at improving the emergency response system in the event of disasters, in terms of organization, the hospital’s internal capacity and Emergency Departments.

6. REFERENCES


