TERRITORIAL RISK AND VULNERABILITY: PLANNING TOOLS AT MUNICIPAL SCALE*

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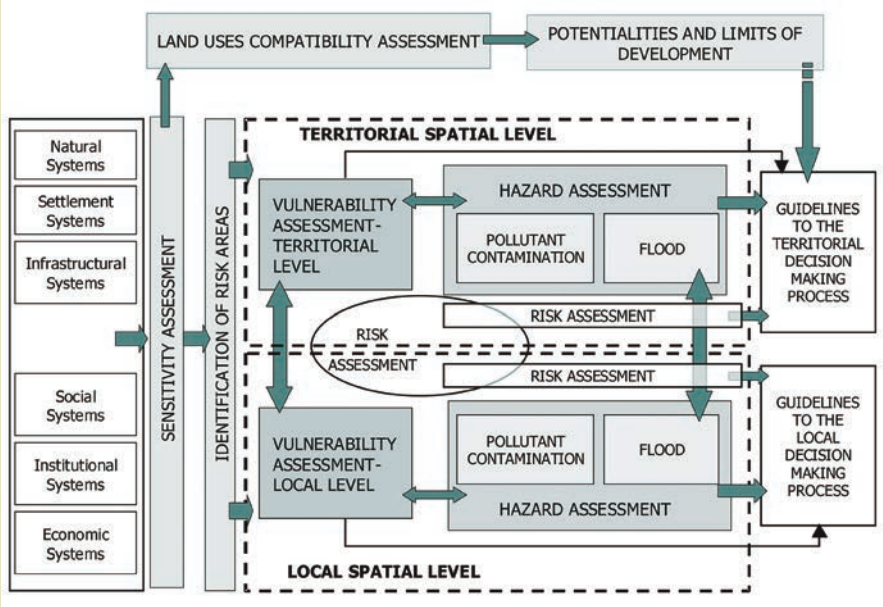

The research methodological framework. Source: Elaborated by the author.

ABSTRACT

The paper focuses on the link between territorial planning and risk management. Starting from the results of an interdisciplinary and international research called Quater-Interreg IIIB, we will underline the importance of territorial knowledge and the role that planning can play to mitigate risks such as floods, landslide and other natural and anthropical hazards. The aim of the research was a kind of certification that would help municipalities learn and operate on their territory. We worked to elaborate a method that can measure the short term and long term decision that public administration should take to turn a risky land into a secure territory. We worked to understand how territorial planning can mitigate the effect of hazard especially on the vulnerability components. Toscolano Maderno (Bs) and Seriate (Bg) are the two case studies in Italy that we will present here. Furthermore, we will introduce the Emergency Plans that we provided for these municipalities and the link that we made with the ordinary tools of planning. In fact we don't think that it is necessary to introduce new tools, but we believe that the importance of knowledge of a territory can be integrated in ordinary planning tools, in accordance with the 12/2005 Act of the Lombardy Region (Italy), and be helpful in the phases of mitigation, prevention and response. An important role that planner can have is in the recovery phase, especially if we introduce the concept of building a resilience city.

KEYWORDS

Risk management, Territorial planning, Emergency plan, Basic knowledge, Resilience.

* This paper is derived from the interdisciplinary and international research Quater-Interreg IIIB. The coordinator of the project was the Lombardy Region (with the scientifically supported by Politecnico di Milano). The other partners were: the Ente Parco delle Madonie (Sicily), the Polytechnic University of Valencia and the University of the Balearic Islands (Spain); ARPA Piemonte (Italy), the Mediterranean Institute of Quality of Toulon and the Region Provence-Alpes-Côte d'Azur (PACA) (France). For the Politecnico di Milano different research groups were involved: territorial planning, chemical engineering, hydraulic engineering, structural engineering and urban development.

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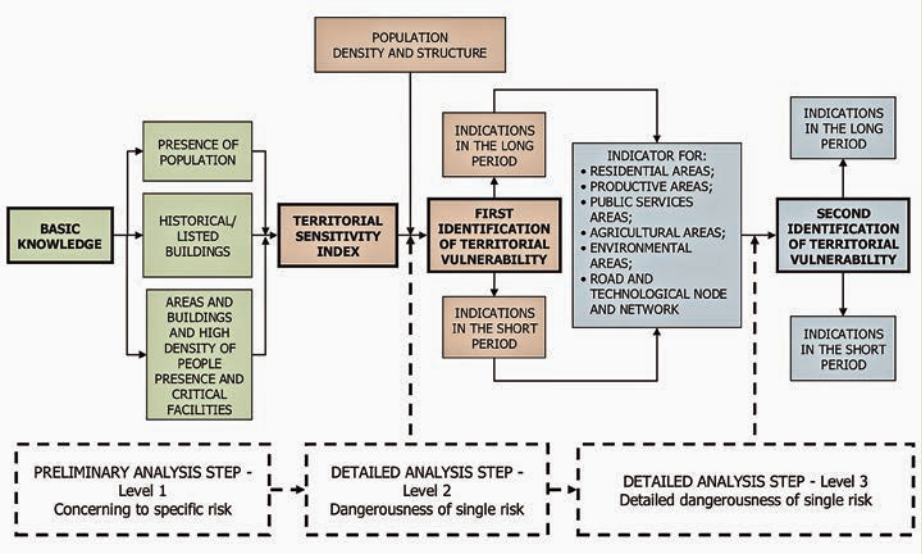
RIESGO Y LA VULNERABILIDAD TERRITORIAL: HERRAMIENTAS DE PLANIFICACIÓN A NIVEL MUNICIPAL



Steps of territorial vulnerability analysis and assessment method. Source: Elaborated by the author.

RESUMEN

El artículo se centra en la relación entre ordenación del territorio y gestión del riesgo. A partir de los resultados de la investigación interdisciplinaria e internacional *Quater-Interreg IIIB*, se hace hincapié en la importancia de los conocimientos locales y el papel que puede desempeñar en la planificación de la reducción de los riesgos, como inundaciones, deslizamientos de tierra y otros desastres naturales como artificiales. El propósito de la investigación era elaborar una especie de certificación que pueda ayudar a los municipios a aprender y trabajar en su territorio. Se trabajó en desarrollar un método para medir las decisiones a corto plazo y largo plazo que el gobierno debería tomar a efectos de conseguir transformar un terreno peligroso en un territorio seguro. Se buscó entender cómo la planificación espacial es capaz de mitigar los efectos de peligro, especialmente en los componentes de la vulnerabilidad. Toscolano Maderno (Bs) y Seriate (BG) son los dos casos de estudio en Italia, que se presentan aquí, además de los planes de emergencia que se han desarrollado para estos municipios y la unión que hemos hecho con las herramientas ordinarias de planificación. En conclusión, no se cree necesario introducir nuevas herramientas, pero si señalar la importancia del conocimiento de un territorio que se puede integrar en los instrumentos de planificación, de conformidad con la Ley de Lombardía (Italia), 12/2005 y que puede ser útil en las fases de mitigación, preparación y respuesta a un evento. Un papel importante que el planificador puede tener es en la fase de recuperación, sobre todo si se introduce el concepto de la construcción de una ciudad resiliente.

PALABRAS CLAVE

Gestión de riesgos, Planificación territorial, Plan de emergencia, Conocimientos básicos, Resiliencia.

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INTRODUCTION

Every year national and local communities face increasing costs due to environmental and technological catastrophic events. The impact of these events on the environmental and territorial system is really complex. Due to increase and overlapping of environmental costs, all institutions (public and private) feel a need to change the government system from emergency to prevention and mitigation actions.

Either in ordinary planning or in sectoral planning like the one of emergency, knowledge of the territory is fundamental. In fact, this analytic phase can become the common base for a planning that takes into consideration the intrinsic characteristics of the territory (represented also from the presence of risks), towards a development and a sustainable and harmonious management of the territory.

The goal of the research QUATER – INTERREG IIIB, is the development of a "procedure handbook for (the) territorial risk management". This will synthetically be illustrated in the first paragraphs of this paper. The different workgroups involved in the research have analyzed the following: territorial vulnerability, flood, landslide, chemical and seismic risk, vulnerability of public buildings. The final goal of the research was to integrate territorial risk prevention into the ordinary planning system of public institutions.

The research was applied on a local scale. In the Italian context, municipal authorities are competent in urban planning and they have a deeper knowledge of the context. The research has been tested on three municipalities with different risks: Seriate (BG), Toscolano Maderno (BS) and Lainate (MI).

On the Municipality of Toscolano Maderno and Seriate, the research has not been concluded with the application of the QUATER method, but it has been continued with the predisposition of the Municipality Emergency Plan (PEC). The general objective of a restricted instrument of planning like the PEC is the predisposition of adequate models of intervention and procedures of emergency to place in action in case of a calamitous event, in order to support the population affected. A description of the innovative elements that characterize these PEC is reported in the 6th paragraphs and followings. The application of methodologies used for integration of the prevention of territorial, anthropical and technological risks in ordinary planning and in daily operating of the Local Agencies is slowly starting to pay off. However, there is still lot of work to be done because these applications do not result in isolate cases, but become instead daily practice of the planner.

THE RESEARCH METHODOLOGICAL FRAMEWORK

The methodology framework (analysis and assessment) is based on the evaluation of potential damages due to territorial risks that characterize the municipal context. Two aspects can be identified in the general methodology: the risk analysis/assessment and the response system. The risk analysis depends on four interrelated factors:

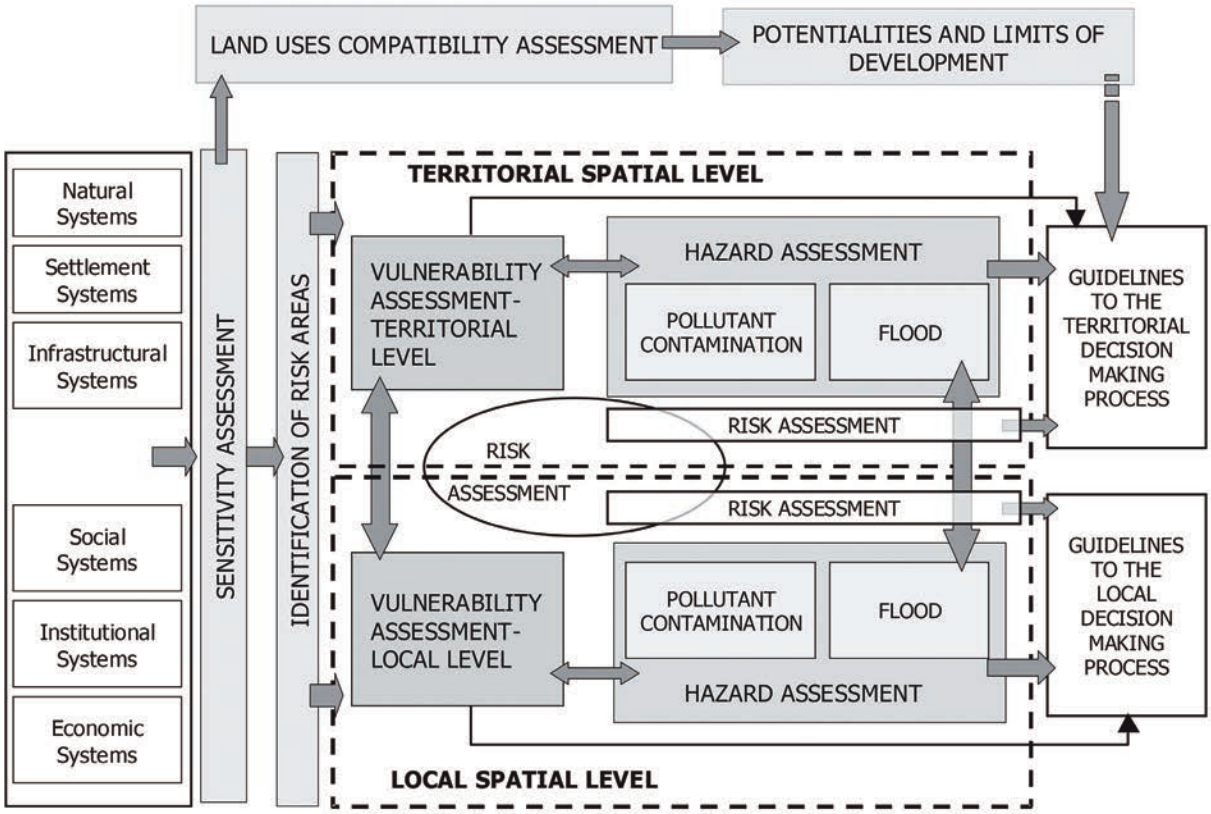
1. Sensitivity – intrinsic characteristics and resources of the municipal territory/context (natural or human).
2. Exposure – number of goods, people and activities potentially involved during the event.

3. Vulnerability – the tendency of goods, people and activities to get damaged;
4. Hazard – the characteristics (intensity, frequency, areas involved) of the hazardous events.

Risk is the result of all these aspects. The analysis of hazard and vulnerability can be extended beyond the municipality boundary (local level and territorial level). The aim is to verify the presence of a potential hazard near the municipality boundary that can have some indirect effects on it.

The response system, based on the risk analysis, is characterized by two intervention levels on the territory: the first considers emergency management measures and risk mitigation interventions (these actions must be implemented in a short period). The second level concerns the territorial risks prevention measures that must be implemented over a long period (and that must be integrated in the planning and land uses plan instruments). (Figure 1)

Figure 1. The research methodological framework. Source: Elaborated by the author.



THE TERRITORIAL VULNERABILITY ANALYSIS AND ASSESSMENT: METHODOLOGICAL FRAMEWORK

The method for territorial vulnerability analysis consists of three steps: a preliminary analysis step (level 1), a detailed analysis step (level 2), and a further detailed analysis step (level 3).

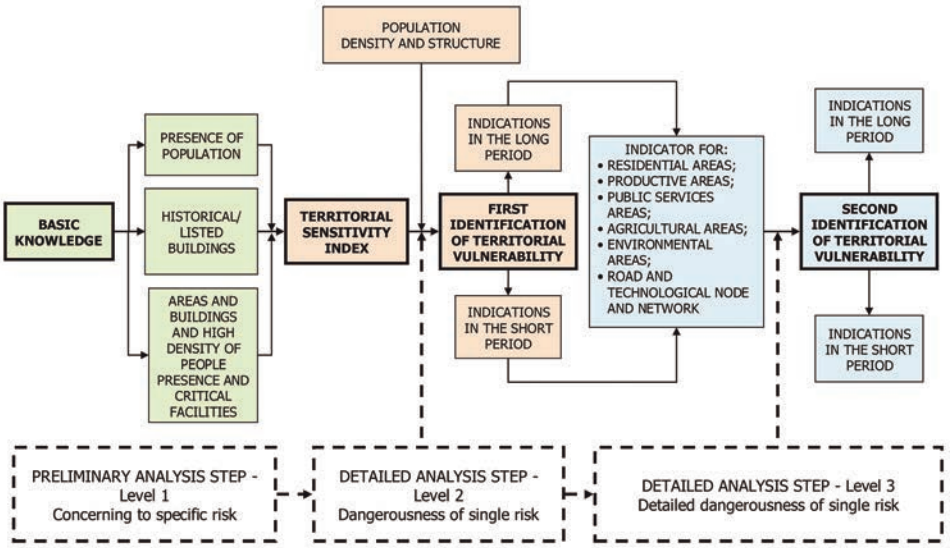
The outcome of the preliminary analysis step (level 1) is the determination of the Basic Knowledge (territorial information/data) concerning the municipality. In particular, this level pinpoints the distribution of the population and the localization of strategic buildings.

The second step (level 2) outcome is an investigation into the sensitivity by means of specific indicators, varying according to the characteristics of each municipality, and a preliminary exposure and vulnerability assessment of the territorial system for each risk.

The detailed analysis step (level 3) enhances the results of the previous step by means of a specific analysis (of the different hazards and area of the territory involved).

The outcomes of these three analysis steps help municipal authorities select an action and intervention system aimed to decrease/reduce territorial vulnerability. Every step uses parameters and indicators that can be used to assess vulnerability and carry out a periodic audit of the certification procedure. (Figure 2)

Figure 2. Steps of territorial vulnerability analysis and assessment method. Source: Elaborated by the author.



Indications

At the conclusion of the detailed analysis, as we have already mentioned, the method allows for the recognition of some indications for the short and long periods. The short period indications are related to emergency management measures and risk mitigation interventions (Municipality Emergency Plan, information campaign for the inhabitants, risk mitigation interventions on strategic buildings). The long period indications are related to territorial risk prevention measures, which have to be integrated in the planning and land use plans instruments (for example a program for new location of strategic buildings and a land use code).

Table I shows an example of short term and long term indications in the case studies of Toscolano Maderno; the indications are divided in mitigation interventions, Civil Protection actions and planning measures (the red line divides short term indications from long term indications). All the indications are related to the analysis that we have made on the Municipal territory.

In the case studies analyzed, the town/city plan was in use from various years and little or nothing had been done to introduce measures of mitigation which not only refer to the dangerousness, but also to the vulnerability of the territory. The long term indications, for future phases of plan updating, would have to be integrated or be held in consideration in order to create the connection between ordinary and sectoral planning which was mentioned before, with the support of the procedures of maintenance of the certification.

Table 1. Example of short term and long term indications. Source: Elaborated by the author.

Indications framework						
	A	Mitigation interventions	B	Civil Protection actions	C	Planning
SHORT TERM	A1	Programming and design of hazard mitigation interventions.	B1	Updating of Municipal Emergency Plan with all risks present on the territory.	C1	Development of internal Municipal office collaboration: development of Territorial Information System.
LONG TERM	A2	Municipal programs finalized to hazard analysis.	B2	Design and development of information campaign for inhabitants.	C2	Verification and comparison with future land use plan and territorial risk.
	A3	Realization of hazard mitigation interventions.	B3	Development of a program to stimulate the intervention to keep the safety of the buildings.	C3	Development of municipality program for new location of strategic buildings.
	A4	Reduction of exposure level for inhabitants and strategic building.	B4	Realization of inhabitants information.	C4	Identification of alternative roads in dangerous areas.
		… … …	B5	Development of municipal Emergency Plan.	C5	Development of new location for public services buildings.
			B6	Arrangement of information about territorial and network vulnerability.	C6	Development of programs and systems for territorial and network monitoring; improvement of Territorial Information System.
				… … …		… … …

An important aspect of the proposed method is the verification of goals and actions. The actions efficacy and the targets gained can be checked in two ways: a continuous enrichment of the Basic Knowledge (which improves the efficacy of the indications) and the monitoring of actions over time.

The methodology realized for the redaction of the Municipality Emergency Plans

As reported in the short term indication from QUATER methodology, we have elaborated the Municipality Emergency Plans (PEC) for the Municipalities of Toscolano Maderno and Seriate. If we go back to the three parts that compose a PEC, we can then disclose the

methodology set in action in the specific cases presented in the introduction. We can also highlight some innovative elements and their relation to the planning and management of the territory.

Firstly, in both cases we have elaborated a multi-risk plan that also takes into consideration those hazards not explicitly cited in the reference norms. The choice we made derived from the consideration that hazards are intrinsically part of the territory and all hazards, in the first analysis, must be considered and analyzed with the exact same relevance. Only after a careful assessment it is possible to decide which ones are negligible in the plan.

Regarding the general structure of a PEC, this is composed of three fundamental parts: the Basic Knowledge, the Operative Part and the Part of Verification and Updating.

The Basic Knowledge contains:

- a territorial organization that must be elaborated independently of the presence of risks;
- the analysis of direct or induced dangerousness, also from a close Municipality;
- the detection of the vulnerable elements exposed to the risks (es. hospitals, schools, zones with elevated population density, technological infrastructures, etc);
- the identification of available resources (es. rapid-reaction force at local and regional levels, areas of reception and/or shelter, vehicles and materials);
- the depiction of the risk scenes.

The Operative Part identifies the systems of monitoring and pre-monitoring an event for the expectable risks (es. the alluvial risk) and the drawing up of the aid models (identification of members of the Local Unit of Crisis that comprise the rapid-reaction force of the Municipal territory; the localization of over-local useful forces of intervention in case of particularly serious events or for a particular typology of risks; for every force involved, the "who - does - what" of the tasks).

The Part of Verification and Updating comprises:

- the verification of the PEC by drill and, in case of incidental events, through the former post-analysis of the procedures of emergency action;
- the updating of the PEC through the identification of protocols for implementing short and long period updates.

For the realization of the PEC we have used GIS, which allows to share and to update the information arranged systematically in a fast and effective way.

The Basic Knowledge of the Municipality Emergency Plans

In the Basic Knowledge, after a general organization of the territory under study (comprised of thematic like: climate, geomorphology, hydrography), we have analyzed the urban settlement and the infrastructural system, the distribution and characteristics of the population, the economic activities, agriculture and public services, the emergency infrastructures and the resources available.

The first phase includes an analysis of population census and the mapping of strategic and vulnerable buildings; the emergency areas available (subdivided in waiting areas, reception areas and recovery areas); the public infrastructures service and resources of Municipal property which could be available in case of necessity. All information obtained in this first part of the Basic Knowledge of a PEC becomes mapped by GIS and in this way we provide a cartography which is always updated and available for the PEC, but also for ordinary planning.

The ideal successive step, today still not completed in these two cases, sees this basic information of the territory, at the moment independent from the typology of present risk, contained into a Municipal SIT (Territorial Information System) where all the councillorships can reach and contribute in the given terms of updating. The structuring of the PEC for this purpose has concurred to supply a common working base in which, once the financial resources have been obtained, a Municipality will be able to build the SIT.

Another important and innovative element in this type of sectorial plan, involves the drawing up and continuous updating of files dedicated to the emergency areas; they contain important information on accessibility, extension, equipment of independent infrastructure service, etc. Often neglected inside the norm of writing of the PEC, usually the planner localizes the areas without dealing with their specific characteristics.

The second phase of the Basic Knowledge of a Municipality Emergency Plan involves the analysis of dangerousness and risks present in the territory. For the Municipality object of the research, the analyses have already been carried out from work groups of project QUATER.

The heart of this phase of surveying the PEC are the risk scenarios, meant from the Regional Directive like verbal and synthetic descriptions, accompanied with an explicative cartography of the possible effects on the population and on the infrastructures, by adverse meteorological events (flooding, also gave away dams), of geologic or natural phenomena (earthquakes, landslides and avalanches), by forest fires, or industrial accidents or of dangerous substances in freight accidents. From the point of view of risk analysis, it is important to emphasize the presence and the involvement of various disciplines and expertise in this phase. These experts have not only supplied a risk assessment on present territory, but also a reflection on relation between these risks and the development of actual urban area, on effect of the future forecast urban growth.

The abilities of planner to represent territory through a reasoned and synthetic cartography are fundamental in order to give back a general picture of risks and the complex systems that compose the territory, that a specific scientific sector does not succeed in condensing. In fact, in the phase of knowledge and planning of territory, we would have to already be notified of the presence of a risk in our area of surveying.

Once again the relation between sector planning, one of emergency and ordinary planning emerge. In fact, new Regional Law of Lombardy 12/2005, considers it obligatory that there is a risk analysis for plans at different territorial levels, the problem is that all risks are not taken into consideration and there isn't a directed connection between ordinary territorial plans with emergency plans that instead consider, as we have previously said, all the types of risk. Localization of a public structure, for example a school, would have to take into consideration not only the economic reasons, but planner would have to also take into consideration the degree of dangerousness in different territorial risks that characterize the area to settle. This information is contained in a PEC.

It is obvious that not always, in our territory, we can refer to new constructions, but we always have to take into consideration public buildings already constructed: in this case, given the impossibility to eliminate risk, the intervention of mitigation would be opportune and useful in order to diminish the possibility of damage caused on buildings. In both cases, a deeper knowledge of territory is necessary, whether in punctual terms (es. localization of the building), or in analysis of various systems that compose it.

The localization inside Plan of Government of the Territory of particular services involved in the emergency phase and in accessible areas, is not subordinate to eventual risks (e.g. municipal civil protection, Red Cross, fire brigade, etc.), it allows to supply a ready answer to emergency and therefore a more effective and efficient management of the event. If we placed side by side these two instruments and a Plan of the Urban Traffic, we could then be sure that the time of reacting to event and the dispersion of forces involved will be limited.

Also regarding the second phase of the Basic Knowledge of a PEC, we have written up a series of explicative cartographies of dangerousness, present risks and risk scenarios that we have decided to adopts for the drawing up of the intervention models.

Another innovative aspect that deserves further discussion, regards the cartography of the risk scenarios. This cartography has been planned in such a way as to have in an only picture all the reference for the portion of territory interested in calamitous event, with indication of strategic and vulnerable buildings, service infrastructures, that have been involved in the event. Where possible, we specified the civic number of building involved and consequently we gave a brief description of the characteristic of single inhabitants. In fact, in the PEC, we have also attempted to distinguish sensitive population, that is young people, old people or disabled ones who need particular assistance in cases of evacuation of the areas at risk.

The Operative Part of Municipality Emergency Plans

As anticipated, the Operative Part of a PEC also characterizes the systems of monitoring an event in premonitory phase and it drawing up the intervention models. The first aids to populations are directed and coordinated by the Mayor of the Municipality involved in the event. The Major, in accord to Italian legislation, is local authority in matter of Civil Protection. In case of events which cannot cope with local resources, the Mayor could ask for assistance at Prefect who activates and manages the over-local forces of intervention. Therefore, the first step in the drawing up of intervention model is the localization of local forces of intervention, they will then be involved in Local Crisis Unit (UCL) and over-local forces will support it.

For every risk scenario contemplated in the Plans, we have identified specific procedures of intervention that, in this methodology are made up of:

- one matrix time/components of UCL; where we identified, subdivided for temporarily and succeeded passages, the activities to place in action part of every member of the UCL (for clarity, main forces of over-local participation are also comprised in the matrix);
- one matrix activity/responsibility; where, for every identified activity we specify the responsibilities of every member of UCL (if he is responsible for an action, if he is simply informed or just supporting);

- a job description for every member of UCL; where the activities placed in head of every Agency are explained. The job description contains all useful and indispensable elements to know in an emergency phase (es. telephone numbers of managers of technological networks, etc.);
- a cartography that summarizes all the main information of the intervention procedures.

Where possible, as an example for alluvial risk, all these procedures of intervention are multiplied for pre-alarm phase, alarm or emergency phase. For not expectable risks, the procedures are formulated only for the emergency phase.

Particularly innovative and interesting in the contents is the job description and the cartography of intervention models. Like we had observed for cartography of risk scenarios, also in this case we can find in a single cartography the necessary information for activation of intervention procedures: one clear map of area interested in event with the indication of interested vulnerable elements, the indication of the ways to escape and the usable emergency areas. This cartography, beyond graphical part, is physically structured with a series of "pockets" where the main intervention procedures have been collected (matrix time/components UCL, matrix activity/responsibility UCL, job description for every member of UCL and a list of population have been involved for typology).

The part of Verification and Updating of Municipality Emergency Plans

All the "architecture of emergency" adjusted with this methodology, introduces to the third fundamental part of a PEC, that Verification and Updating of data and information are contained in it.

The verification of a PEC generally occurs by drill, in case of incidental events, through former-post analysis of procedures of emergency. Closely correlated at verification of plan there is the periodic updating, necessary in order to be able to manage the emergency better, because PEC must be used as a dynamic and modifiable instrument in consequence of changes of territorial system to which it belongs. For the review of PEC we have identified a protocol of updating a short and a long period. The updating of short period regards population exposed (with particular regard to the sensitive population) the members of UCL, the over-local forces of intervention and all the information that changes or could change in a minimal temporal arc. The updating of a long period regards territory (which changes independently from presence of risks) and present dangerousness (that could modify in the light of new studies).

Also in this phase there is a strong relation between emergency planning and ordinary planning that can, with its decisions, aggravate or mitigate a present risk.

From the operational point of view, the updating of a PEC is therefore also conceived inside a Municipality which adopts a system of certification like that one proposed from QUATER method, it is useful to emphasize the necessity of a strong collaboration between several operative sectors of Municipality, from the office of Civil Protection to the Technical Office up to the Registry Office.

CONCLUSION

The QUATER method develops a procedure handbook of territorial risk management not only with short period actions, but also with some indications for risk mitigation and prevention in a long term vision. The method aims at integrating risk mitigation aspects in ordinary planning.

The procedure allows the arrangement of information about territory (Territorial Information System) and develops a public and private collaboration.

The system is managed by Municipality, in a flexible and incremental way, through a constant process of goals update and verification. Moreover, the support of planning instruments such as a sectorial Emergency Plan, directly connected to ordinary planning and to certification process, allows to achieve those goals which were initially set for mitigation of risk through the planning instruments.

Table 2: The innovative elements inserted Municipality Emergency Plans. Source: Elaborated by the author.

	Innovative elements	Relation between ordinary planning
Basic Knowledge	Analysis of dangerousness also outside the municipal boundaries	Use of the same information about the territory inside the Municipality SIT
	Organization of the information by GIS	Use of the same information about the dangerousness and risk inside the Municipality SIT
	Interactive cartography	
Operative	Design of the intervention procedure with matrix, job description and interactive cartography	Coordination of the choice take in the ordinary planning and sectorial planning, in order to avoid a worsening of the situation at risk and to mitigate the effects.
Verification and Updating	Protocol of updating of the information organized by GIS	Continuous updating of the information regarding the territory and the Municipality goods

The task of making connection between these two typology of plans more effective is still a lot. We do not think that the introduction of new instruments of planning is necessary, but that the correct and sustainable use of existing instruments is enough. As planners, we think that we can't stop to think of single destination of land use, the instruments of mitigation in our "hands" are various (eg. adoption of particular building regulations, maintenance and promotion of the use of particular natural buffer areas, etc.) and it is necessary to enter in the perspective that in order to plan a secure territory, we must think of different levels of action in space and time and that a synergy between various sectorial expert is necessary.

When we think about "resilience", we often think only to recovery of a city in post-event phases, almost as if this stage was a sort of "closure" quantifiable. Instead, for resilience we mean the ability to get out of a stalemate, so do not necessarily equal to the initial pre-event. The ability of a territory to be resilient consists largely from organization and from relationships existing prior to event, more the system will be flexible and more rapid will be the recovery to normal activities with a view to improvement and awareness.

Often, the concept of sustainability is partnered by resilience. Sustainability, in fact, does not necessarily mean that all risks are eliminated, but that a degree of balance between the issues related to risk, social and economic ones are reached. Certain levels of risk may be necessary and acceptable. Where a community chooses to continue living in a territory,

despite risk, the development should go towards the creation of cities resilient, able to react to the effects of a disaster. This type of approach, namely to know and to work on nature and not against it, can simultaneously achieve the goals of conservation and enhancement of natural resources without diminishing the chances of developing [Burby, 1998].

The integrated use of appropriate tools for management and planning, as we've tried using in the territories of Seriate and Toscolano, it is necessary for try to plan a resilient city, reducing intensity of development in hazardous areas, reducing need to alter and hinder natural processes, we could reduce the economical and social costs, of vulnerable city.

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