

Preventive urban planning tools for emergency and crisis in La Paz (Bolivia)

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Abstract

Considering the limits of preventive action and the weaknesses of crisis management, this paper aims to demonstrate the relevance of a spatial approach to crisis management and the need to expand research on this issue. We have thoughtfully conducted research on the types of crisis management areas and territories to consider. An application is proposed in La Paz: identifying crisis management areas in order to link those areas where the population is particularly vulnerable to areas with healthcare resources. The example shows that a spatial approach to crisis management allows us to go beyond disaster preparedness. It establishes relationships between preparedness, prevention and mitigation planning.

Keywords

Crisis management, spatial approach, vulnerability, preparedness, prevention, preventive planning, La Paz

Introduction

The issue of the natural or anthropic origin of risks appears to be more and more relevant each day. Indeed, damage caused increases year after year (Blaikie, 1994 ; Dubois-Maury, Chaline, 2002 ; Pelling, 2003 ; Pigeon, 2007) and calls into question development models throughout the world (Davis, 2006a). This is a logical trend, following the increase in the world population: with more inhabitants, more elements for societies' functioning are exposed to damage (Dauphiné, 2001 ; D'Ercole, Metzger, 2004). As the population is continually more concentrated in cities (Davis, 2006b; Pigeon, 2007), the most frequent damages and most important damages, accumulated over a long period of time, occur there.

Faced with such a situation, the most common response has been constructed from a definition of risk based upon the notions of hazard-vulnerability, which suggests intervening primarily in terms of hazards (Pigeon, 2005 ; Metzger & D'Ercole, 2009 ; Hardy, 2009). Therefore, most scientific research attempts to enhance knowledge of hazards, although this approach seems to be very insufficient. Whatever country we consider in the world, this approach has led to the construction of protective structures intended to resist hazards (Hardy, Musset, 2008). Nonetheless, these structures, which can be very useful in some cases, have shown considerable limitations (Dauphine, Provitolo, 2007). Some questions have even been raised about their unforeseen effects in increasing damages (Pigeon, 2005). In this context, it is relevant to base the question of risks on an understanding for what makes up vulnerability (D'Ercole & al., 2009).

In the urban context of the South, vulnerability is changing and intensifying in most cases. This vulnerability is not only about being susceptible to damages, but also the propensity of urban society to generate them, amplify them, and make vectors of new vulnerabilities. It has become much more active rather than passive (D'Ercole & al., 2009). This particular dynamic is the consequence of several factors: increasing exposure to destructive hazards because of intense urban development; urban transformation which does not integrate local development conditions or which is not planned in the long term; increasing poverty and social exclusion; a reduction in the means allocated to preventive development.

From these reports, if it is useful to maintain research on prevention, particularly to improve preventive urban planning. It is also essential to think about emergencies and the way to improve crisis management systems, so as to not simply abandon these cities to their fate. However, in this field, research has barely considered the spatial and territorial dimensions of crisis management, which could clarify the complexity of emergencies and the uncertainty that characterizes them, by taking into account the multiple and overlapping spaces, actors and territories engaged in crisis management. This reasoning can easily lead to tools for preventive planning focused on emergency and crisis, which is what this article intends to establish. This proposal is based on the experience of the PACIVUR¹ program developed within the framework of a scientific cooperation agreement between the French Research

¹ Andean Program of training and research about vulnerability and risks in urban environment.

Institute for Development (IRD) and the Municipal Government of La Paz (GMLP) since September 2008. The research program aims to better understand what makes up the vulnerability of urban centers – in this case La Paz – starting principally from a spatial and territorial approach to emergency management and crisis.

This text first concentrates on showing how operational concerns, tied to a retrospective analysis of events which have involved damage, allow us to reflect on emergency and crisis. Secondly, this reflection is situated in the paradigmatic context of risks. This justifies a diagnosis of the risks in La Paz which led to the implementation of a scientific cooperation agreement with municipal authorities in order to develop knowledge and tools which would be more suitable to the context. Thirdly, the management of emergency spaces and crisis will be analyzed through the following stages: identification of vulnerable spaces and spaces of emergency management and crisis; reflection on the tools for emergency management and crisis assistance; an analysis of their vulnerability; an analysis of territorial vulnerability.

1. Why do emergency and crisis in Southern cities matter?

1.1 Damaged areas and areas at risks

Analysis of past events involving damage, which have brought about emergencies and/or crises, allows us to get to the heart of understanding the vulnerability of urban territories. Retrospective analysis of past events allows us to differentiate areas - risk areas, damaged areas – thus causing us to question the factors which led to an emergency and/or a crisis. For example, on January 25, 2008, a section of a drain which transmits non potable water collected by the drinking water utility, from Hampaturi reservoir towards Pampahasi treatment plant, was damaged by a landslide (figure n°1). This section is located in an area where landslides can occur (without being precisely identified or mapped). In this case, the hazard area and the damaged area correspond. In passing, one observes that the map of the hazard area does not contribute much unless it is coupled with a map of the urban operation elements which can be lost.

The area where the transport pipe of non-potable water is located was not the only damaged area. In fact, a few kilometers away, the Pampahasi treatment plant could no longer function, depriving the Southeast area of the city of La Paz of drinking water from the distribution network. This area of the Hampaturi-Pampahasi system has also faced an emergency state: it was necessary to provide drinking water to its population (34% of the population of La Paz)

but also to its hospitals (423 beds distributed in 46 health centers) and its companies (a layoff situation) (Hardy, 2009).

Retrospective analysis of events involving damage reveals that there are various areas to take into account in states of emergency and/or crisis. Damaged areas brought about risk areas where emergency and crisis have had to be managed. The crisis showed that there can be multiple crisis areas: places of damage which is also the site of conflict with rural communities of Hampaturi; places of problems with the potable water supply in the city of La Paz, etc.

This example indicates that the analysis of past events allows us to identify areas with strategic elements to protect, to analyze their vulnerabilities; it also invites us to establish who the different actors of the situation of crisis are. It offers a framework to think about preventing future malfunctions.

1.2 Resource spaces for emergency and/or crisis management and their vulnerabilities

If the example of the non-potable water transport pipe damaged by a landslide contributes to establishing that there are various types of spaces, it also invites us to theorize that there are areas which allow for the return to a normal situation, i.e. emergency and/or crisis management areas. Such areas can be different from other the previously identified areas or on the contrary, nested within them.

In the example of the break in the potable water supply, it was necessary to find out how to limit the malfunctioning that the loss of this strategic element would imply for urban operation. Thus the installation of a system of distribution tankers permitted the delivery of potable water to inhabitants and to other strategic elements in the risk area (Hardy, 2009). In this case, potable water and tankers must be regarded as elements of emergency management. In January-February 2008, they were brought in from areas outside the risk area. Consequently, the identification of elements which are resources for emergency and/or crisis management implies being interested in areas of emergency and crisis management, and in their vulnerabilities.

On February 19, 2002, a hail storm caused several floods and landslides in the urban area of La Paz, causing extensive damage. At least 69 people died, the majority of whom were female

informal street vendors. 130 people were wounded and 50 were reported missing. The structural damage was evaluated to \$10 million USD (damage to roads, vehicles, public and private buildings like the Policonsultorio – a health center located on Manco Kapac avenue), not to mention the disruptions to electricity and drinking water supply which worsened the malfunctions during the emergency. Moreover, approximately 200 families were obliged to abandon their damaged housing (Hardy & Combaz, 2009).

Once again, retrospective analysis of the event has permitted mapping the damaged area along with the area which was in demand for medical crisis management (figure n°2). They are different areas. Affected areas are located in the center of the city and in the southern districts built in the area around the Choqueyapu torrent. The hospitals which were in demand are all located in Miraflores district area.

In spite of this dissociation of areas, there were transmissions of vulnerability from one to another. Whereas the hailstorm occurred between 2:20 p.m. and 3:45 p.m., the requisitioned hospitals to treat the victims (*Hospital de Clínicas, Hospital del Tórax, Asistencia Pública*) could only receive the first one as of 5 p.m. (Villegas, 2002: 19). In fact, the floods cut off mobility on roads considered to be essential. For example, a length of over 70 meters of the road which linked the southern district Florida with the district of Aranjuez was destroyed, isolating Aranjuez from the city, particularly from Miraflores. In the city center, the concentration of hail caused the loss of certain sections of roads, provoking a loss of mobility in the central part of the road network, which also involved a loss of accessibility to other areas of the city, like Miraflores, which is an essential area to solve emergencies. Thus, the access/dispatch of rescue operations like ambulances, between the impacted area in the center and the Miraflores district, was difficult. Nonetheless, in a period of emergency, the rapid response of rescue operations is paramount, especially when the injured suffer from hypothermia. But this quick response was affected by the loss of accessibility, which thus had negative consequences on mortality (Hardy, 2009). Through this example, one concludes that the spatial dimensions of crisis management produce vulnerability, constructed by the spatial and functional articulation of two types of areas to identify. This conclusion leads to further reflections on crisis management and its integration in preventive urban planning.

2. Context and methodology developed to think about crisis management and its integration in preventive urban planning

2.1 Evolution of research on risk

Knowledge of the physical and human processes at the origin of natural catastrophes has increased significantly during these last decades, accompanied by the improvement of techniques to anticipate catastrophes and intervene in a preventive manner. Yet, at the same time, one observes a very significant increase in the number of victims, and material and financial losses caused by these catastrophes. The list of the cities damaged by a major catastrophe has not ceased to expand and diversify (Dubois-Maury, Chaline, 2002), particularly in Southern countries. This paradox is revealing frequently observable distortions between risk management policies and the risks evaluated by scientists.

In other words, if scientific production regarding risk can be considered abundant, it leads to conclusions which are seldom taken into account by decision makers – it does not allow for the efficient reduction of risks. There are significant failures in terms of preventive urban planning and, in many cases, it is not due to a lack of sensitizing urban managers. Thus, today several authors like Blaikie et al. (1994), Saury-Pujol et al. (2001), Tunstall (2004), Pigeon (2006) or Werritty (2006) recognize the partial effectiveness of the preventive policies of risk management (territorial planning or physical protection) and agree on highlighting the impossibility of eliminating risk. This is why the recent evolution of perceptions of risk management appears in the increasingly popular concepts of acceptable risk and uncertainty management. In this context, the question of crisis management becomes essential in a very great number of territories exposed to various risks.

Whereas in the past crisis management was considered a concern dictated by the force of events and as a stopgap due to lack of prevention, it is gradually taking centre-stage, at the heart of risk management systems. The growing number of researchers who are interested in crisis management shows this increase of crisis as research object in the field of risk whereas a few years ago, these problems were a matter reserved for specialists in civil security.

Being interested in crisis management is not only necessary due to the limits of preventive action, but also due to the often inoperative character of existing crisis management systems, particularly in developing countries.

There are numerous analyses in this direction. To mention only some Latin-American examples, one can quote Voight (1990) on the eruption of Nevado del Ruiz in Colombia and the disappearance of the town of Armero in 1985; Rocha and Christoplos (2001) on hurricane Mitch in Nicaragua in 1998; Lane et al. (2003) concerning the eruption of the Tungurahua volcano and the difficult evacuation of the town of Baños in Ecuador in 1999; D'Ercole et al. (2007) in connection with the crisis related to the earthquake of August 15, 2007 in Pisco (Peru). All these analyses highlight the difficulties of management of complex situations. The underlined problems point to the weaknesses of institutions regarding coordination and organization, principally with problems of communication rather than with economic and material concerns. Defects in terms of prediction and preparation, ignorance of the affected areas and their capacities, poor articulation between national and local levels, between the authorities and the population, often lead to improvised emergency and crisis management not based upon solid knowledge.

2.2 A diagnosis of the vulnerability of La Paz

The vulnerability of the agglomeration of La Paz has already been stressed (O'Hare & Rivas, 2005). However, it continues to intensify. In this context, a research team of the PACIVUR program from the IRD established a diagnosis starting from the analysis of past events, on behalf of the Municipal Government of La Paz (GMLP) to intend to explain this situation (Hardy, 2009).

On the one hand, it is impossible to eliminate hazards because (1) risk areas are already largely urbanized and (2) the existing preventive systems face many limits in terms of effectiveness. Figure n°3 illustrates this example. It superimposes the urban fabric in 2006 with the preventive zoning defined in 1977 which took into account the suitability of the grounds for building according to their exposure to hazards (BCEOM & al., 1977). Despite the recommendations, urbanized surfaces have been developed in the exposed zones and it would be rather difficult to give them up. This situation results partly from lax control of urbanization and from the non-adaptation of existing preventative tools.

In addition, La Paz is continually more and more exposed to damage. Urbanization continues to progress and consequently, there are always more elements of urban operation exposed to damage. The agglomeration of La Paz, made up of the municipalities of La Paz and El Alto, is in constant growth, both in terms of population and territory. In less than 60 years, El Alto's

population has multiplied by more than 80, from 11,000 inhabitants in 1950 to more than 896,773 inhabitants estimated in 2008, exceeding the number of inhabitants of the historical municipality of La Paz. At the same time, the urban surface has been extending, as in La Paz where, in just over 30 years, it was multiplied by 5.5 passing from 3,300 hectares in 1976 to 18,009 hectares in 2007.

Parallel to this growth, socio-economic inequalities do not seem to be reduced. For example, the non-existence of a legal land reserve that returns the land access to the poorest individuals has become almost impossible since it is too expensive. However, there is no housing policy intended to compensate for this situation. Under these conditions, it is illusory to succeed in imposing any preventive planning which would strictly control the establishment of settlements throughout the territory according to the level of risk.

Lastly, crisis management systems which currently exist are partially inoperative: they are badly organized and have many defects in terms of preparation. For example, the populations which move into risk areas are often the poorest. Many have recently migrated from the rural and mining Andean Altiplano towards the agglomeration of La Paz. They have limited knowledge of exposure to risks and they are ill-prepared to face them. Yet authorities have not anticipated these problems by adapting the emergency and crisis management system. Because of the absence of organization of emergency simulation drills, authorities are completely unaware of the reaction of the populations faced with such problems.

This diagnosis led the IRD team to propose deepening reflections on emergency and crisis management in La Paz to the GMLP.

2.3 A scientific cooperation program about crisis management

In developing countries, one could observe crises of relatively weak amplitude at the origin of major dysfunctions, as was the case in La Paz during the floods of February 19, 2002 (O'Hare & Rivas, 2005; Hardy, 2009). This is why the PACIVUR program team, within the framework of a scientific cooperation agreement signed in 2008, suggested to the GMLP to think about the means of avoiding, anticipating, confronting and overcoming the catastrophes and accidents, the crises, the sudden disturbances of urban society (D'Ercole & al., 2009).

From this point of view, partners think about several questions: what are the territories at stake in a crisis? How to identify them? What are the spatial and territorial dimensions that are at work in crisis management? How to analyze them? What are the vulnerabilities of crisis management systems that can be updated by the spatial and territorial approach?

At same time, the team asserts the applicability of the knowledge built within the framework of scientific cooperation, as a tool to aid in decision-making, to lead to preventive actions, particularly by analyzing the conditions of vulnerability.

2.4 Knowledge development and emergency and crisis management tools

Since risks are so numerous that they interact and cover almost all the territory, the authorities of La Paz are helpless, and face trouble in defining priorities, directing actions and adopting an effective risk prevention policy.

The concept of risk expresses the possibility of losing what one considers important. This is why the reasoning of operational research, consisting very simply of asking what is important to try to understand why and how one could lose it, is a matter of common sense. Consequently, research on risks in La Paz is the result of perfectly empirical reasoning to try to exceed the operational limits of hazards reasoning. Faced with the impossibility of using knowledge on hazards, which constitutes the essence of work available on risks, and the inconsistency of vulnerability analyses, coupled with the concrete need for decision makers to direct their prevention policy, the idea was that risk prevention in an urban environment could be carried out through the identification of what is at stake in the territory of La Paz.

The identification of the major stakes of a territorial system, independent of any risk, probably constitutes a fundamental base for the production of useful knowledge for risk prevention in an urban environment. Indeed, if research claims to contribute to risk prevention, starting by identifying what one wants to protect (the major elements) makes good sense. More so if these major elements return to concrete objects of the urban systems operation, which make sense for territorial managers (D'Ercole & Metzger, 2009: 395).

From the point of view of emergency and crisis management, it is a question of identifying what is at stake: vulnerable areas to help in priority and resource areas for the resolution of the

emergency and crisis; but also to precisely comprehend their vulnerabilities so as to reduce them.

3. Emergency and crisis areas in La Paz

3.1 Identification of vulnerable areas

Vulnerable areas are areas likely to be affected by a disaster, they present fragilities and they will have to be helped. This identification of vulnerable areas has become a traditional stage of risk studies, which try to establish the vulnerability of the population and represent it spatially.

In La Paz, the research team has gotten down to work on this task. For this purpose, in the general 2001 census of the population the team selected criteria which seemed most relevant to evaluate the population's vulnerability. For example, the age of the individuals seemed to be important as it influences the means necessary for emergency response. Elderly or very young individuals need specific assistance compared to young adults during a state of emergency. In a certain manner, information on the equipment in a household can refine an understanding for the population's vulnerability. If a household has a telephone line, its occupants will be able to call for help more easily. The entirety of selected criteria was considered in a matrix to map population vulnerability in La Paz in the scale of the census zones (figure n°4).

However, this reasoning which uses census data consists of mapping population vulnerability at night. But the retrospective analysis of events shows that an emergency might occur at night as well as during the daytime. To integrate the temporality of the emergency in the analysis, the team has tried to develop a map of population vulnerability by daytime. Using a census of formal economic activities in La Paz, combined with pupils enrolled in schools, it established a first map which corresponds to the daytime population concentration (figure n°5). Starting from these two maps of population vulnerability, one can start thinking about the adequacy of the emergency services, by taking temporality into account.

This example of population shows how to identify vulnerable areas, while underlining the complexity of the operation when one starts to integrate temporal factors into spatial ones.

However, it should be stressed that the spatial dimension is not only vulnerable because it concentrates populations. Even if the population is the principal element of an area, other concrete objects of the operation of urban systems, can make these areas vulnerable because of their spatial location.

3.2 Identification of crisis management resources areas

Parallel to the identification of vulnerable areas, the team is interested in the identification of areas which have essential resources to handle emergency and crisis. For example, these emergency and crisis management resource areas concentrate the decision-making centers and the operational resources to implement assistance.

Starting from the lesson drawn from the catastrophe of February 19, 2002, the GMLP developed a Center of Emergency Operation (COE). It organizes various actors in three large spheres of activities, in case of emergency or crisis: humanitarian operations (health, refuge, social services, food and nutrition, psychological support); logistical support (transport, communication, storage, etc) and population protection operations (rescue and evacuation, maintenance of order, etc). Various departments of the GMLP participate in the COE as well, as external actors (various entities of the national police force, particularly firefighters; the Bolivian Red Cross; Bolivian Civil defense and various entities of the Bolivian Armed forces; etc) (figure n°6). These actors represent resource-elements for emergency and/or crisis management, i.e. institutions which have specific facilities to face the situation and, through their complementary actions, to facilitate the return to a regular situation.

The COE actors were mapped according to their role (figure n°7). The database established through this mapping lets every actor know what resources they have and what resources the other actors with whom they must work have available.

3.3 Vulnerability analysis of emergency and crisis management resource elements

Identifying emergency and crisis management resource areas is not enough to guarantee their good performance. Other parameters must be taken into account to determine their vulnerability. Indeed, it is not enough to have defined the COE actors, or to have mapped their characteristics, in order to guarantee their performance. Various parameters can prevent them from performing. To acknowledge what can prevent them from operating we must analyze their vulnerability. Six criteria of vulnerability can be identified.

For example, the performance of COE elements can be made vulnerable by exposure to natural hazards. Indeed, should natural events occur, these elements must be functional to fully play their part. Figure n°8 superimposes the location of COE elements with the cartography of natural hazards. It reveals that the unit of emergency attention is located in a spatial grid where five natural hazards are likely to appear. It has an elevated exposure to hazards which calls into question the relevance of the location of this COE actor.

Accessibility is another parameter that allows for the evaluation of the vulnerability of an emergency and crisis management resource element. For this reason basins were determined according to their level of accessibility. Accessibility takes into account topographical and functional criteria (major roadways, input/output points for the basin, public transportation flow, etc). By superimposing this information onto the emergency and/or crisis resource elements, we are better able to consider their vulnerability. A first analysis of the vulnerability of healthcare can reveal that it is not very vulnerable: it involves the participation of many doctors who are present twenty-four hours a day; there is an electric generator which provides energy in case of a power-out, etc. But, when considered in its spatial context, healthcare appears to be very vulnerable, because it is located in an area with reduced accessibility (few roads, roads very often congested by the traffic, roads often cut by floods/landslide). In figure n°8 we can see that the Irpavi public hospital, Prosalud, is located in the basin of Irpavi whose accessibility has been deemed defective. That means that in an emergency, although this hospital has all the internal characteristics of an emergency hospital, it may not be accessible for the possible injured, because of its location.

3.4 Analysis of the vulnerability of the territory

Analyzing the vulnerability of emergency and crisis management resource elements makes us wonder about the vulnerability of the territory. The example of a particular element such as ambulances will let us better demonstrate this.

In the organizational chart of the COE, the GMLP defined a specific field for emergency medical help, in which it identified actors according to their abilities. In fact, this field of medical help and health appears as an essential component in emergencies and/or crises (D'Ercole & Metzger, 2004; Lagadec, 2007). Its malfunctioning is likely to make rescue operations ineffective, thereby justifying the need to control it.

Within the organization chart of the COE, the Health department of the GMLP and the Bolivian Red Cross are present. In many ways, these two actors appear to be essential in this field, but only one of their roles is considered, that of acting as an ambulance resource.

The Health department of the GMLP and the Bolivian Red Cross are the actors that manage ambulances for transportation of injured people. In fact, a network of ambulances was created in 1996 (network 165) and was placed under the responsibility of the Health department of the GMLP, which located the ten vehicles on the sites of public hospital emergencies (*Hospital de Clínicas*) in Miraflores district. Meanwhile, the Bolivian Red Cross has three ambulances located near the town center and in the district of Miraflores (Chol, 2009). Of course, there are other ambulances in the municipality likely to be mobilized in a state of emergency or crisis, except for the fact that their owners do not appear as COE actors. Why? And what does this situation reveal?

Firstly, no database has an ambulance count in La Paz. Neither the health department of the GMLP, nor the SEDES La Paz², or any other organization that works in the field of health has a comprehensive view of the fleet of ambulances as a resource. At best, each ambulance actor has information on its own resources. Under these conditions, the element of ambulances acknowledged by the COE can only be those managed by the Health department of the GMLP and by the Bolivian Red Cross, both members of the COE.

This very partial knowledge of the ambulance fleet resource element in La Paz can cause serious problems in states of emergency and crisis. Indeed, it implies that the COE can only call upon the ambulances of the 165 network and the Red Cross. Not only does this situation reduce the number of available vehicles compared to the total existing fleet, it increases the time for intervention, which is essential in the case of an emergency evacuation of injured people and their transportation to a healthcare center. Indeed, these two actors have placed their ambulances in the central part of the city. The lack of information on the location of ambulances will, in the case of an event occurring in the periphery, oblige the COE to call up a vehicle located far away from the affected place, although an ambulance may be available nearby. On the other hand, territorial knowledge of the ambulance fleet resource element,

² Health region of the Department of La Paz

constructed by reflecting on its usefulness in emergency and crisis (state, location, characteristics, schedules of running, etc) can clearly improve emergency medical help.

This example shows that knowledge of resources of crisis management and their vulnerability unquestionably improves the performance of a municipal COE. Adopting this methodology for all resource elements, would considerably improve knowledge of territorial vulnerability and thereby improve emergency and/or crisis management tools. In this fashion, the effectiveness of risk management policy in the municipality of La Paz would be improved.

Conclusion

By carrying out a diagnosis of urban vulnerability starting from a retrospective analysis of events involving damage and cases of emergency and crisis, various areas are identified and the question of the objectives of reducing vulnerability can be raised: what to protect? From what and at what cost? Under which conditions? In this way, a research program with operational purposes can be developed.

In partnership with the Municipal Government of La Paz, the PACIVUR research team undertook an analysis of territorial vulnerability which seeks to understand where and how vulnerability is generated and diffused in urban areas. The research team is particularly interested in areas of emergency and crisis: vulnerable areas, areas of emergency and crisis management. It seeks to establish their vulnerability. It carries out a careful reflection on what emergencies or crises are, both at a municipal and at a local level. This reasoning seeks to make proposals for territorial planning in hopes of reducing the losses of elements for urban operation, by aiming for greater effectiveness in targeting areas of intervention according to the degree of disruption that they are likely to cause. This reasoning is also interesting insofar as it provides a track to radically reconsider risks, while being freed from the conceptual and operational shackles imposed by the primacy of natural hazards in a risk approach.

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