

## CONCEPTUAL APPROACH TO RISK ANALYSIS AND ESTIMATIONS

Carmen Calderón Patier\*, Jose Luis Cuenca Tadeo\*, and Ana Fernandez Ardavín\*\*

\*Universidad San Pablo-CEU<sup>1</sup>

\*\*Universidad Nacional de Educación a Distancia (UNED)<sup>2</sup>

**Keywords:** Disasters, risks, management efficiency; prevention and mitigation.

Post submission acceptance edited by proceedings editor.

### Abstract

Recently disasters are becoming a more concerning and dimensional problem. The insufficient and incorrect information coming from the social agents, the lack of institutional and social organization, the lack of preparation to attend to emergencies, political and economical instability of the affected areas make more difficult the potential consequences of any disaster and increase the risk since the capacity to support the impact is reduced. This is the context behind this paper in which we provide a conceptual and theoretical approximation for analysing and estimating risks as a way to contribute to improve the management efficiency on this area. This will help identify and give priority of efficient action for prevent-eliminate the disasters, to reduce risk.

### Introduction

Recently disasters are increasingly becoming alarming problems and also having a greater international impact. Demographic growth together with the processes of urbanisation tending to expand over vast territories, the ever increasing poverty of groups, the use of inappropriate or old organisation systems and the continual pressure over natural resources are producing a progressive increase of settlement's vulnerability due to exposure to a wide variety of natural dangers.

Although research in this area has become more common, unfortunately it is not enough (Atkins, J.P.; Maiz,S and Easter, C.D. 2002). Ex post research about natural disasters trying to quantify damages (whatever they are direct or indirect or secondary) it is obviously very important to evaluate effects on economic growth and development of the areas or countries that have suffered such events, this quantification it is also very important to make people aware of the need to establish preventive policies that allow territorial and regional emergency planning in the short and long term.

The lack of awareness of this problem does not only affect populations but also the politicians and people that are responsible for decision making. They are the ones responsible to inform,

---

<sup>1</sup>**Carmen Calderón Patier; Jose Luis Cuenca Tadeo**

San Pablo-CEU University, C/ Julian Romea nº 20, 28003 Madrid, Spain

Telf: 00 34 91 - 456.6300, E-mails: [calder@ceu.es](mailto:calder@ceu.es); [cuetad@ceu.es](mailto:cuetad@ceu.es);

<sup>2</sup>**Ana Fernandez-Ardavín Martínez**

Universidad Nacional de Educación a Distancia (UNED),

C/ Avda. Senda del Rey 11, Madrid, Spain

Telf: 00 34 91 - 398.6378, E-mail: [afdz-ardavin@cee.uned.es](mailto:afdz-ardavin@cee.uned.es)



educate and make people aware of the kind of risks that they might be exposed to. These circumstances cause an increasing vulnerability due to ineffectiveness on risk management. Thus factors like the insufficient and often wrong information that social agents hold, the absence of social and institutional organisation, the deficiencies on response to emergencies, political and economic instability, make the potential consequences of any disaster much more dangerous. In other words, these factors increase risks since they reduce the capability to support the impact.

This work develops within this context forging a different conceptual and theoretical framework. The approach attempts to provide the tools to analyse and evaluate risks, as a way to contribute to a better efficiency on the management of this field, and to allow identifying effective and efficient measures to prevent and minimise disasters in order to reduce risks.

This work is divided in three parts. In the first place there is a brief historic introduction of the concepts “disaster” and “risks” and the evolution of their meanings. In the second part, risk is analysed more in depth, from the perspective of threat, vulnerability to the more specific analysis of risk. And finally the main conclusions are presented as well as some recommendations about the need to improve prevention policies on disasters as a way to obtain a more suitable management of risk.

### Historic approach

The concepts of disaster and its associated one of risk have changed through time - not only its social perception but also the views of different disciplines that have studied it. The first social and scientific research on disasters began in the United States in the decade of the twenties (Cortés Canarelli, B.2002). The field was restricted to natural disasters ( i.e. earthquakes, volcanic eruptions, hurricane, floods ...) they were seen as unexpected. Thus the causes of these phenomena were often explained in terms of either fate or religion and often considered as unavoidable. This perception of disaster produces resignation as the only way to deal with it since human beings are powerless to stop disasters or to reduce their damage. The consequence is that these studies are only about patterns of rescue, and strategies to gradually recover and get back to normal.

From 1940 to the 1970's the concept of disaster changes from a perspective of natural sciences to one of social sciences. The tendency is towards studying the population's behaviour and response to emergency situations. This approach includes studies about individual and collective reactions. Also the so called “Ecologist School” that was originated in the University of Chicago in the forties, formulates the problem from a social and environmental perspective. Later this School would become the basis for the development of applied social sciences. They remark that disaster does not imply necessarily a natural event but their main contribution is the need to take into account the capability of a community to adapt to different events and circumstances whether they are natural or technological.

By the end of the seventies and during the eighties, an event is only considered as a disaster when it produced losses and it overcomes the ability of the population to support themselves or when the course of events prevent the population from recovering normality. In other words vulnerability cannot be defined or measured without taking into account the capability of the population to absorb, respond and recover from the event's impact. The origin of disasters is beginning to be discussed, questions like why and how it happens are being formulated and the need to evaluate and manage risks is promoted.

It will be in the nineties when prevention is introduced and formulated as an essential part of the phenomenon (Safety culture). Then it is recognised the need to look for mechanisms that allow society to minimise or to avoid the effects of the disaster even before it has occurred. Emergency public services are questioned as well as management and its processes of co-ordination and communication. In this sense it is obvious the need for a whole concept and



evaluation of the problem from a variety of disciplines and basically for the first time there is a search for a theoretical and coherent framework of risks as preventive from disasters.

The concept of risk associated with disasters has experienced an evolution parallel to the concept of disaster (UN, 1979). The natural science perspective is a partial and a reductionist approach that has allowed us to obtain gradual knowledge of an essential part of risk that is the threat. Applied sciences (in the 1980's) were directed towards the effects of one element of the event rather than the event itself. On the contrary, to study the capability of a system to maintain its function or ability implies a change of paradigms to understand disaster. The social science approach tended to treat the problem of risk by considering that vulnerability and even threat, often can be the result of social political and economic processes.

We can infer the need to accurately define and limit the concept of risk, in a way that allows its estimation and intervention from a multidisciplinary approach and in order to get an effective and efficiency management of disasters.

### **Risk analysis**

The difference between disaster and risk have been established. A disaster is a situation that results from the expression of a phenomenon that has a technological or natural origin and that in a context of vulnerability produces serious and intense dysfunctions in the normal living conditions of a community (Wasgate, K.N. and O'Keefe, P.1976.). In other words, damages are of such dimension that society is unable to face, absorb and recover from those damages by itself using its own resources. The existence of a disaster implies the previous existence of determining conditions of risk.

On the other hand risk, defined as the probability of future damage, is the result of a latent danger associated with the possibility that dangerous phenomena may be present and with specific characteristics of the society that has certain disposition to suffer several degrees of damage (UNDP, 2001). Risk means some kind of danger for every individual in a predisposed community. Once that risk is recognised by the community implies that something must be done to reduce it. Collective action is often required to solve the problem and must involve a compromise from the social agents, authorities, public services, private sector and the whole community.

The level of risk of a society is often related to its degree of development and its capability to modify those risk factors that are a potential threat. In this sense disasters are risks that have not been managed properly, but risks are socially constructed even when the physical disaster associated to it is caused by a natural phenomenon (Barton, A.H.1969).

There are three levels of risk analysis:

1. When it is associated with the probability to reach certain critical stages.
2. When the consequences of various critical stages are estimated and associated with its probabilities.
3. When the effects analysed are within a wider context such as the whole society or a part of it.

Generally speaking, risk analysis can be understood as a supposition that risk is the result of relating threat and vulnerability of exposed elements aiming at identifying the possible social, economic, and environmental effects and consequences associated to one or several dangerous phenomena. A change in one or more of these parameters modifies the risk itself, that is to say, the total of expected damage and consequences in a particular area.

To sum up, in order to analyse risk it is necessary to follow three steps:

- 3.1) To estimate threat or danger
- 3.2) To evaluate vulnerability



### 3.3) To estimate risk

#### 3.1) To estimate threat or danger

Threat is related to the possibility that an event may occur and might affect an individual or a system in a place and during a certain period of time. The degree of threat is linked to the intensity as well as to the period of time that the phenomena takes to happen or is expected to happen.

Generally speaking threat evaluation is realised combining probabilistic analysis with physical behaviour analysis of the generated source. Information about past events is used and a similar model to physical systems is constructed. In other words, to be able to quantify the probability that an event may happen with a certain intensity and during sometime of exposition, it is necessary to have as much information as it is possible regarding the number of events that happened in the past and about its intensity.

In summary to evaluate a threat is to predict that a phenomenon may happen based on studies of generating mechanisms, monitoring the disruptive system or registering events through time (Quarantelli, E.L.1997). A prediction can be made based on search and interpretation of premonitions signs or events in the short term. It also can be done using probabilistic information about occurrence parameters indexes. In the long term it can be based on determining the maximum probable event in a period of time that can be related to the planning of the potentially affected area. This kind of evaluation is generally made by technological or scientific institutions related to the fields of geophysics, meteorology, hydrology and technological processes.

Threat maps are made from this point of view; they locate potentially dangerous areas and are a very important tool for territorial planning. When a forecast is made in a specific time, it is called a prediction by which is intended to precisely determine when, where and what dimensions the success may have and to be able to previously inform to the threatened population.

#### 3.2) To evaluate vulnerability

Vulnerability analysis is the study of an element's ability to absorb or resist the impact of a outcome manifested by a threat. Vulnerability analysis is an important development and has contributed analytical and experimental research on new models and methodologies to estimate the system's possibility of error, confidence and security (Cannon, T. 2001.).

Vulnerability evaluation is a process by which the degree of susceptibility and predisposition of an element or a group to be harm by a particular threat is established. Thus contributes to risk knowledge through the interactions of such elements with the dangerous environment (Benson, C.2001). These elements are the material and social context formed by persons, resources and services that can be affected by the manifestation of an event. In other words, it involves human activity and systems constructed by human beings (buildings, infrastructures and the people that use them).

#### 3.3) Risk estimation

Risk relates a threat possibility of an event and with a specific intensity and with the vulnerability of exposed elements. Generally, risk is evaluated in physical terms due to difficulties that imply to quantify social vulnerability (Cardona Arboleda, O.D. 2001). Thus "specific risk" refers to expected damages in a particular period and is expressed as a percentage of value or cost for substitute risk elements. (In terms of fatalities and economic losses). "Relative risk" will analyse relative vulnerability using indexes that allow to introduce quantitative values.



Once that specific and relative risk is analysed, a level of “acceptable risk” is defined as the possible social, economic and environmental consequences that implicitly or explicitly a society may assume or tolerate. Technically speaking “acceptable risk” would be a probability value of some consequences within a reasonable period to establish the minimum security requirements covering protection and planning objectives to face possible disasters (Jordan, R. And Sabatiny, F.1998).

Risks can be shown by maps where potential effects of a disaster with a certain intensity are graphically portrayed depending on the element's vulnerability degree. These maps allow not only intervention planning but also help to elaborate contingency plans that operative organisations should do in preparation for emergency and recovery phases.

The ratings can be expressed in various indicators of economic, social or structural character. In fact most of the empirical works carried out in this field have been focused on calculating these indicators; these studies often apply econometric techniques as well as statistical methodologies to obtain such variables and analysers; sometimes optimization models are used for this purpose.

A novel technique that links quantitative analysis with graphic representation of the indicators is the multivariate Data Analysis MDS (Hair, J.F.; Anderson, R.; Tatham, R. and Black, 1995). The indicators and analyses obtained by this method will allow decision makers to establish an area as a region with specific characteristics of specified risk and vulnerability. A group of indicators for a specific area locates a n-dimension point (Rn) that can be compared to other areas of risk. These indicators indistinctly can contain information in anyone of the four scales in which the variables can be divided. The dimension points can be expressed in nominal, ordinal, reason or interval scales. This multiscale dimension of indicators and analyses is one of the most important characteristics of this technique to allow decision makers to take advantage of a new simulation of risk (Real Deus, J.E. 2001.) Within this framework it is possible to simulate indicators of different areas such as the economy, social climate, environmental perspective, ecological aspects, etc.

The MDS technique determines similarities referred to a space of low dimension (two or three dimensions) in those that summarise the information contained in the multiple previously defined indicators. The technique also determines which axes that organize the information are contained in the points. This technique contributes two important points to risk analysis: on one hand, it allows similarities to be identified among areas in the different topics. On the other hand, the meaning of the axes associated with variables not directly observed by the MDS tool can be identified or included in the obtained points dimension.

The mitigation of the risks also has to do with the timely administration actions and response so that goods, services and economic, social activities of all types stay in suitable levels to those that previously to the catastrophe existed. In the attainment of this objective the techniques of analysis of the critical and optimal are found by applicable techniques. “Time is money” was said in the eighties, this has led to the appearance of the systems of “just in time” administration systems. Timely administration means an improvement of the effectiveness and social efficiency.

The methodology often used in developed countries to evaluate risk is the analysis cost-benefit, where investment in security and prevention is related to possible damage in terms of victims and harm to infrastructures. Obviously those areas that are very vulnerable and where disasters occur frequently investment in prevention – mitigation will be compensated by cost reduction of damages. However in areas less vulnerable the increase of prevention-mitigation cost, from an economic point of view, does not compensate since the probability that a disaster may take place is relatively low. This is precisely what happens in underdeveloped countries therefore this technique is not very appropriate in these cases.



## Conclusion

At the present time, natural disasters are an unsolved problem, in the sense that they must not be considered only as natural events but rather as situations produced by an interaction between natural factors and the organisation and structure of a society.

In developed countries, regional and urban policies as well as economic ones do not adequately take into account problems related to risk and disasters. Even if there are governmental institutions to reduce risk, the results have been very unsatisfactory since their actions have been directed towards solving emergencies rather than preventing risk situations in a systematic and organised way. There appears to be a lack of political determination in this subject. In poor countries the situation is even worse and even though they could still include policies on risk prevention they are far from doing so.

The nature of risk is very complex and its acceptance depends on many factors. Analysis and evaluation of risk related to disasters involves many disciplines. This situation makes it very difficult to elaborate a unified theoretical framework of risk and - to the date - there are few isolated studies and particular applied cases. Any advance in this direction will contribute to make risk management easier to handle by authorities and societies, since they are key actors to promote preventive measures to face disasters.

## 6.- Authors biography

**Carmen Calderón Patier**, is an Assistant professor in the General Economy Department at the Universidad San Pablo CEU, Madrid and where she has been teaching public finances and taxes for the past 14 years. She received her Ph.D. in 1996 from the Universidad San Pablo CEU de Madrid. She has participate in several national and international conferences and has published more than 15 papers in general economy and taxes other fields in national and international reviews. Her research interest is risk management, public economic and financial markets.

**José Luis Cuenca Tadeo**, is an Assistant professor in the Quantitative Method Department at the Universidad San Pablo CEU, Madrid where he has been teaching statistical and econometric for the past 16 years. He received his Ph.D. in 1995 from the Universidad Complutense de Madrid. He has published more than 10 papers in statistical and econometric fields in national and international reviews. His research interest is decision making, risk management and risk evaluation.

**Ana Fernandez-Ardavín Martínez**, is an Assistant professor in the General Economy Department at the Universidad Nacional de Educación a Distancia, Madrid. He has been teaching from the last 11 years. She has participated in several national and international conferences and has published more than 10 papers in general economy, economic quantification and other fields in national and international reviews.

## References

Atkins, J.P.; Corn, S. And Easter, C.D. (2000), Commonwealth Vulnerability Index for Developing Countries: The Position of Small States, Commonwealth Economic Paper Series 40, Commonwealth Secretariat, London.

Barton, A.H. (1969), Communities in disaster: sociological analysis of collective stress situations, New York, Doubleday.

Benson, C. (2001):. Macroeconomics Concepts of Vulnerability: Dynamics, Complexity and Public Policy.. International Work-Conference on Vulnerability in Disaster Theory and Practice. University of Wagenisngen, Netherlands.



Cannon, T. (2001):. Vulnerability Analysis and Disasters.. International Work-Conference on Vulnerability in Disaster Theory and Practice. University of Wageningen, Netherlands.

Cardona Grove, O.D. (2001)": holistic Estimate of the seismic risk using complex" dynamic systems. Doctoral thesis presented in the Polytechnic Universitat of Catalunya. Escola Superior Technique D'Enginyers of Camins, Canals i Ports. Barcelona, September 2001.

Cortés Canarelli, B. (2002):. Disasters and processes psicosociales: from the crisis in the administration toward the administration of the crises.. Doctoral thesis. MIMEO.

Jordan, R. And Sabatini, F. (1998):. Political Economy of Natural the Disasters: Prevention and Training., EURE, XIV, Have 43, Santiago.

Hair, J.F.; Anderson, R.; Tatham, R. And Black, W. ( 1995): "Multivariate data analysis with reading". Ed. Prentice Hall International Editions, New Jersey. Pp. 484-527.

Real Deus, J.E. (2001): " Escalamiento multidimensional", Ed. La Muralla, S.A. y Hesperdies, S.L., Madrid.

UN (1979)": Prevention and mitigation of disasters. I summarize of the current" knowledge. Volume 7 economic Aspects. Office of the Coordinator of the United Nations for the aid in cases of disaster, Geneva. United nations, New York, 1979.

Quarantelli, E.L. (1997)": you Have criteria for evaluating the management of community disasters." Disasters n° 21, p. 39-56.

UNDP (2001): Feasibility Study Report Global on Risk and Vulnerability Index. Trends per Year, UNEP/DEWA/GRID for UNDO/Emergency Response Division, Geneva.

Wasgate, K.N. and O'keefe, P. (1976):. Some Definitions of Disaster., occasional paper No. 4, Disaster Research Unit. University of Bradford.

