

CONCEPTUAL APPROACHES CONCERNING RISK, VULNERABILITY AND ADAPTATION

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ABSTRACT – This paper presents the main current conceptual approaches concerning risk, vulnerability and adaptation. Traditional studies focus mainly on the physical aspects (geomorphology, physical environment) of risk and vulnerability. This paper aims to present a conceptual framework covering both human and biophysical aspects of risks and vulnerabilities to flooding determining different practices, methods and strategies of adaptation. The reason the authors have chosen this approach is because 'a disaster is not a physical happening, it is a social occasion'. Natural disaster agents, have social consequences only because of the activities of involved communities, before, during and after the impact of a disaster. There is a lack of articulation between natural and social sciences, which has been the focus of research by environmental anthropologists at international but also at national level. In order to overcome this barrier, the paper aims to look at a conceptual common ground, bringing together concepts such as: risk, vulnerability, adaptability, sustainability and new ecological thinking.

Key words: risk, vulnerability, adaptability, sustainability, new ecology.

1. Introduction

The purpose of this paper is to outline a conceptual framework for studies of risk, vulnerability and adaptation to flooding, which are applicable to other types of hazards too. Traditional studies focus mainly on the natural aspects (geomorphology, physical environment, and hydrology) of risk and vulnerability. Conventional adaptation strategies to flooding are usually top-bottom approaches involving implementation of structural methods such as hydro-technical works (Ielenicz, M, Erdeli G, Marin I. 2007) or engineering solutions (Grudnici F, Ciornei I., 2007), which do not consider social aspects (Sing, S., 1997), community local practices or the impact of these works on landscape (Patru I. 2005) and river discontinuity - transversal (Zaharia L, 2012) and longitudinal (WDC, 2000). The

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reason why we have chosen this approach, to paraphrase Quarantelly (2005), is because 'a disaster is not a physical happening, it is a social occasion'. Natural disaster agents, have social consequences 'only because of the activities of involved communities, before, during and after the impact of a disaster (Quarantelly E. H., 2005).

There is little evidence that 'social and physical scientists are on the same wavelength and would arrive at a common perspective' on disasters and anthropologists with their perspective on the link between nature and society and culture may be able to create the necessary theories and 'clarify the important distinction between symptoms, the disaster events and processes themselves, and their underlying and largely systemic causes.' (Oliver -Smith, A1999).

The articulation between natural and social sciences has been the focus of research by environmental anthropologists at international level (Escobar A., 1999, Scoones I., 1999, Asdal K, 2003, Neumann R. 2009).

New ecology concepts presented in this paper seems to be bridging the gap in between nature and society by integrating conflicting paradigms such as patchiness and temporal variability, which are essential properties of both natural and social systems.

Landscape Ecology with Hierarchical Patch Dynamics framework (Wu & Loucks, 1995) links new ecology concepts and its most important contribution is the fact that 'incorporates heterogeneity and scale and integrates equilibrium, multi-equilibrium and non-equilibrium perspectives applicable to both society and nature'.

Furthermore, new ecology thinking presents the non-linear, chaotic nature of natural events which can lead to disasters.

2. Concepts used in risk approaches

A clear theoretical framework determines an appropriate use of research methods and helps social researchers understand the natural sciences concepts and vice-versa. Furthermore the environmental anthropology field uses concepts that feel the gap between social and natural sciences. Using an up-to date comprehensive conceptual framework (e.g. new ecological thinking) is essential for both natural and social fields and impacts the way natural resources are managed (Scoones, I. 1999). The concepts presented in this paper - risk and perception of risk, vulnerability, adaptation, sustainability and new ecology concepts - are relevant to understand the adaptation of local communities to natural disasters

The current period is marked by major changes in the scientific approaches, both regarding concepts and methods (Armas, I, 2006). Recent climate changes are often associated with risks and disasters and more sciences must redefine concepts to keep pace with changes in the natural environment that can be explained mainly by interdisciplinary and trans-disciplinary approaches (Armas I, 2008).

The natural risk discipline is an example of a trans-disciplinary science developed through incorporation of several sciences: geography, geology, biology, ecology, medicine, sociology, communication science, political science (especially new political ecology), economics, psychology (Armas I, 2006).

Researchers from these fields bring their own conceptual models to risk and vulnerability studies, however it needs to be a 'common language so that vulnerability and adaptation research can move forward (Brooks, N. 2003).

A large number of definitions and complex concepts hinder communication between researchers and communication with people in risk situations. In order to address confusions regarding the use of risk and hazard terminology and as required by 'Hyogo Framework for Action 2005-2015', UNISDR (United Nations Office for Disasters Risks Reduction) produced and disseminated the standard terminology on disaster risk reduction. This is available from http://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf.

2.1. Risk Society

We will approach the specific terminology involved in risk studies from the perspective of a “risk society”, as coined by the German sociologist Ulrich Beck in 1986.

Ulrich Beck alleges that there is a connection between risks and modernization. Beck believes that the society at the end of the XX century is not a post-modern society but a reflexive modernity society, emerging from the constraints imposed by the classic industrial society. From Beck's point of view in a risk society 'social production of wealth is systematically accompanied by the social production of risk' and the risk is a systematic way to address hazards and insecurities induced and introduced by modernization itself.

To support his argument Beck advances five assumptions: (1) risks in a risk society are essentially different than risks induced by industrialization in previous societies, inducing irreversible, immediate and invisible harm to all life forms ' (2) the most vulnerable people are those in social risk positions and media, researchers and legal experts defining risks become important social and political players (3) the risks are like a bottomless pit and their 'diffusion' and 'commercialization' elevate the capitalist society to a new step, for a privileged person 'being' determines 'risks consciousness', while for an unprivileged person situated in a risk position 'consciousness determines being'; (4) possession of wealth implies paying for the associated risks, but some of the risks are uninsurable; and (5) social risks contain political explosives - the risk society is a society of disasters.

Beck maintains that the risk society is characterized by globalization - 'the poverty is hierarchical, the smog is democratic', polluting industries are transferred to poor countries, societies oscillate between hysteria and indifference regarding

risks presented by media, extreme risks are associated with extreme poverty, the risks have a boomerang effect and the supra-nationality of pollutant movement cannot be resolved through national efforts.

Piers Blaikie, one of the most important thinkers in development adds new elements to the conceptual framework of risk society coined by Beck. 'At Risk'(1994) demonstrates that social vulnerability and the diverse forms of risk are the root cause of disasters and emphasizes a sociological approach to disasters: risk + vulnerability = disaster.

Blaikie et al. (1994) point to following social factors contributing to vulnerability: economic imbalances, disparity in power among social groups, knowledge dissemination and discrimination in welfare and social protection (p. 5). The authors demonstrate that people most often live in areas of hazard because their survival depends on appropriating natural resources. Race, class, gender, and ethnicity all affect social susceptibility to hazards and less powerful social groups are more at risk to natural hazards.

'At risk' points out that the social, economical and political factors contributing to vulnerability and risk are very difficult to resolve and these problems can destabilize the power of governing bodies. As a result people in power will focus on natural or engineering aspects of a hazard avoiding 'explosive' problems such as social vulnerability and equity. The authors propose a framework to analyze risk - the Pressure and Release (PAR), based on the commonly used equation: Risk = Hazard \times Vulnerability In this context vulnerability is defined within three progressive levels: root causes, dynamic pressures and unsafe conditions.

Most of Blaikie's case studies and experience are from the developing world. In contrast Morrow B.H. (1999) demonstrates that poverty is patchy and is inherent to developed countries and gives examples of communities from Florida disproportionately affected by Andrews Hurricane in 1992. Marrows proves that there is an unequal access to opportunities and exposure to risks, which are seen as consequences of socio-economic systems.

Morrow (1999) defines risk as being equal with Hazard \times Exposure \times Probability, which implies that in an ideal situation decision-makers are provided with adequate information about the hazard itself, correct information on community's level of exposure and estimations of the probability of being impacted they can make reasonable estimations of personal risk. However human behaviour is far more complex especially when choices are made under risky conditions.

2.2 Conceptualization of vulnerability

The ordinary use of the word 'vulnerability' refers to the 'capacity to be wounded', being the degree to which a system is likely to experience harm due to exposure to a hazard (Turner II et al., 2003). The vulnerability term is

conceptualized in different ways by scholars from different knowledge domains and even within the same domain (Fussler, H. M., 2007). For instance, natural scientists and engineers tend to apply the term in a descriptive manner while social scientists tend to use it in the context of a specific explanatory model (O'Brien et al., 2004). Social scientists tend to view vulnerability as a set of socio-economic factors determining people's ability to cope with stress or change and consider that social aspects are a product of inequities. Climate scientists often view vulnerability in terms of the likelihood of occurrence and impacts of weather and climate related events and others (Turner II et al., 2003) sees vulnerability as integrated in the complex human-environment interaction (Brooks, N. 2003).

One of the most commonly accepted way of vulnerability conceptualization is the one developed by Bohle (2001) which distinguishes between an "external"(exposure) and an "internal" (coping) vulnerability. The exposure side refers mainly to the structural dimensions of vulnerability and risk, while coping refers at action to overcome or mitigate the negative effects of economic and ecological change (see Fig. 1). Exposure is often conceptually considered and discussed, while the internal side of coping is usually neglected.

Three key conceptual modes and research directions serve in understanding the whole range of coping strategies:

1. Action-oriented approaches, especially on the interaction between the external and internal side of vulnerability or, in Giddens' A (1979) terms, 'structure' (or institutions) and 'agency' (or action carried by subjects). Structure and agency are a duality that presuppose one another (Giddens, A. 1979). Humans create both their consciousness and the structural conditions that make their activities possible. Because social actors are reflexive and monitor the flow of activities and structural conditions, they adapt their actions to their evolving understandings.

2. The concept of access (related to action theory) to coping resources or 'assets'. Assets can be: economic, socio-political, infrastructural, ecological and personal assets and people attempt to control to reduce their vulnerability and strengthen their resilience. The more assets (including social assets) they control, the less vulnerable they are and the greater are their capacities to successfully cope with risks, stress and shocks.

The access to control over assets is closely linked with the political economy of the region under consideration and in which way various people and communities are embedded in the basic structures and dynamics of society, economy, and polit.

3. The third basic conceptual approach - conflict and crisis theory - refers to the capacity to manage crisis situations and solve conflicts, a basic determinant for successful or less successful coping with change and the accompanied risk (Bohle, H-G. 2001).

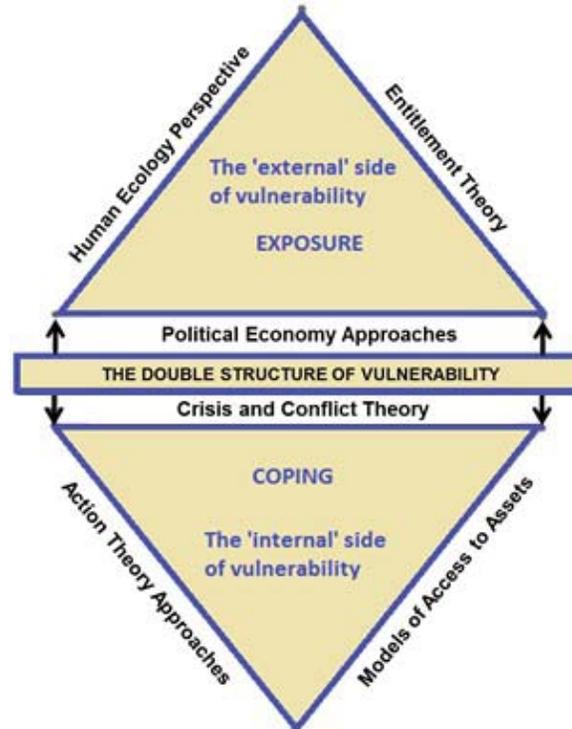


Figure. 1 Bohle's conceptual framework for vulnerability analysis (2001)

United Nations (2004) distinguishes four groups of vulnerability factors that are relevant in the context of disaster reduction: (1) physical factors, which describe the exposure of vulnerable elements within a region; (2) economic factors, which describe the economic resources of individuals, populations groups, and communities; (3) social factors, which describe non-economic factors that determine the well-being of individuals, population groups, and communities, such as the level of education, security, access to basic human rights, and good governance; and (4) environmental factors, which describe the state of the environment within a region. All of these factors describe properties of the vulnerable system or community rather than of the external stressors.

One of the most comprehensive conceptualisation of vulnerability, which emphasis a local and global dimension is described by Fussell (2007) who alleges that there are four categories of vulnerability factors classified according to the dimensions sphere - internal or external- and knowledge domains - socio-economic and biophysical. The socio-economic internal factors are household income, social networks, access to information. The socio-economic external ones are: national policies, international aid, economic globalization the biophysical internal:

topography, environmental conditions, land cover. The byophysical external are: severe storms, earthquakes, sea-level change.

In Cutter et al (2003) conceptualization of risk (an objective measure of probability of a hazard) interacts with mitigation (a measure of risk or its impact reduction) to produce a potential hazard. The potential hazard is either moderated or accentuated by a geographic filter (place and its situation, proximity) or by the social context, which includes the community's experience regarding that hazard and its ability to respond to it, influenced by economic, demographic and housing characteristics.

Perhaps Birkmann (2006) provides one of the best overviews of the different spheres of the concept of vulnerability (Fig. 2). Birkmann rightly points out that it might be misleading to try to establish a universal definition of vulnerability, which is very difficult as it is exemplified in Table 1. The complex way in which vulnerability is conceptualized reveals that although the concept of vulnerability has achieved a high degree of recognition in different fields, such as disaster management, environmental change research and development studies (Birkmann, J. 2006), the 'concept is still somewhat fuzzy and often used with differing connotations'.

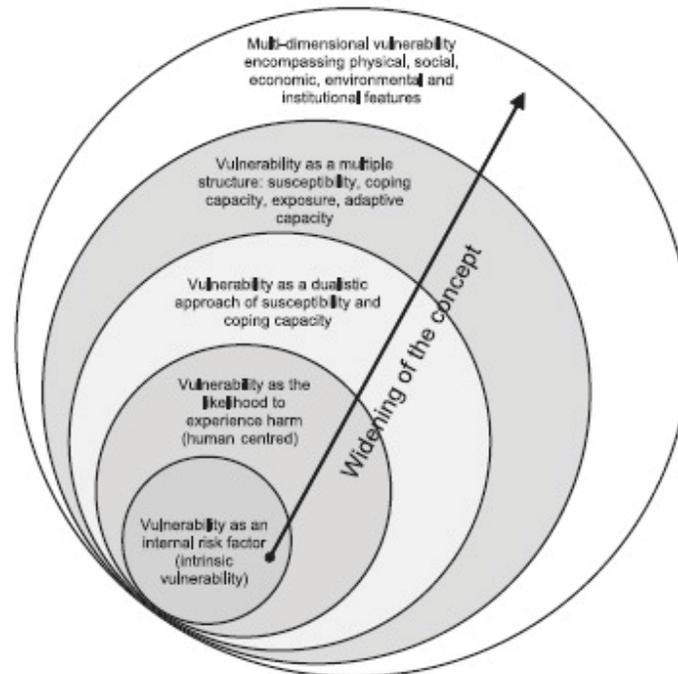


Figure 2. Key spheres of the concept of vulnerability after Birkmann (2005)

Table 1 Conceptualization of Vulnerability (up to 1994, the review is a compilation of authors discussed by Cutter in 1996)

Author (s)	Conceptualisation of vulnerability
Gabor and Griffin (1980)	Vulnerability = risk context
Susman et al (1984)	Vulnerability = degree to which differnt classes of society are differentially at risk
Kates (1985)	Vulnerability = capacity to suffer harm & react adversely
Mitchell (1989)	Vulnerability = potential for loss
Liverman (1990)	Distinguishes between vulnerability as a biophysical condition and vulnerability defined by political, economical and social conditions; vulnerability in geographic space (where?) and in social space (who?)
Alexander (1993)	Vulnerability = function of the cost and benefits of inhabiting areas at risk from natural disasters
Cutter S. (1993)	Vulnerability = likelihood that an individual or group will be exposed to and adversely affected by a hazard; the interaction of the hazard of space (risk + mitigation) and social profile of communities.
Blaikie et al (1994)	social vulnerability & risks are the 'root cause of disasters'; being a person or group's capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. A combination of factors 'determine the degree to which someone's life and livelihood are put at risk by a discrete and identifiable event in nature or society'.
Cutter S. (1996)	3 distinctive themes = vulnerability at risk/hazard exposure + vulnerability as social exposure + vulnerability of places
Cutter S et al (2003)	Vulnerability paradox (despite evidence social aspects are still largely ignored) Cutter introduces SoVi = Social Vulnerability Index integrated into different GIS programmes, a very useful index
The ESPON Hazards project (2003) according to Kumpulainen S. (2006)	vulnerability = degree of fragility of a person, a group, a community or an area towards defined hazards. Vulnerability is a set of conditions and processes resulting from physical, social, economic and environmental factors increasing the susceptibility of a community to the impact of hazards.
Brooks N. (2003)	Distinguishes between social and biophysical vulnerability, the latter is often viewed in terms of the amount of damage experienced by a system in an encounter with a hazard.
B.L. Turner II et al (2003)	Vulnerability is central to sustainability research, 'the basic design of vulnerability includes the capacity to treat coupled human-environment systems'.
Barry Smit & Johanna Wandel (2006)	vulnerability of any system (at any scale) is reflective of (a function of) the exposure and sensitivity of that system to hazardous conditions and the ability or capacity or resilience of the system to cope, adapt or recover from the effects of those conditions.
Fussel (2007)	In discussion about climate change he identifies for groups of vulnerability factors classified according to the dimensions sphere - internal or external- and knowledge domains - socio-economic and biophysical.

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Author (s)	Conceptualisation of vulnerability
Fekete A. et al. (2008)	Vulnerability = cross-scale issue, especially in climate change; discussions on scale issues are permeating the vulnerability community; multi-scale assessments experience an increasing interest in vulnerability; there is a link between vulnerability assessment and sustainable development, because both address three spheres: social, economic and environmental
Adger N.W et al. (2008)	vulnerability of distant peoples and places to global change in environment and society are nested and teleconnected. Vulnerability = function of the exposure of a system and its sensitivity to stress, shocks, and adverse change, and its capacity to cope with and adapt to such disturbance. Vulnerabilities are interdependent through the mechanisms that increase exposure or sensitivity. These mechanisms =: the processes of global environmental change; second, the changing structure of economic markets; and, third, material flows of resources, people, and information.
Hahn et al. (2009, apud Preston, 2012)	LVI = Livelihood Vulnerability Index Provide development organizations, policy makers, and public health practitioners with a practical tool to understand demographic, social, and health factors contributing to climate vulnerability at district or community level
Preston 2012	vulnerability is an effort to recognize that a) systems are often affected by multiple forces, of which one is climate change; and b) future ecological and societal vulnerability in a changing climate is determined by factors that are independent of climate change. As such, vulnerability has strong linkages with the development and natural disaster management communities.

2.3. Adaptation

Adaptation is a term originating from ecological theory, in which context it refers to the ability of an organism, human or non-human, to survive and reproduce itself in a particular environment, which has a Darwinian influence. Moran (1979, 1982, 2000) draws a distinction between “adaptation” and “adjustment”, essentially contrasting genetic and behavioural responses to environmental constraints.

Contemporary studies of human adaptation reflect a growing interaction between social/biological sciences (Moran E. 2000). The integration of social and biological approaches was facilitated by acceptance of the ecosystem concept. Moran's study on 'Human Adaptability' derived from biological ecology, which views all organisms as part of ecological systems and human beings third-order consumers 'The ecosystem approach helps develop explanatory models of human behaviour that is possible from a strictly social or cultural approach' (Moran E., 2000).

The author of 'Human Adaptability' also alleges that the concept of adaptability varies greatly depending on the specific of the population in discussion. People will adjust to environmental condition in specific ways that

represent both, present and past conditions. For example, a desert population that has existed in that environ for millennia will differ significantly in its responses to desert conditions than a population that migrated there only in the past generation.

On an different aspect Fussel (2007) alleges that human adaptation to climate change is not well-defined and delimited because there is a diversity of adaptation activities, illustrated by four key dimensions:

(1) Climate-sensitive domains domains (agriculture, forestry,water management, coastal protection, etc. (2) Types of climate hazard (3) Predictability of climatic changes;(4) Non-climatic conditions.

Adaptation occurs against a background of environmental, economic, political, and cultural conditions that vary substantially across regions (Smit. et al 1999).

2.4. Sustainability

Some scientitsts working in the field of natural disasters (TurnerII.et al, 2003, Birkman 2006, etc.) approach vulnerability in connection with sustainability, which aims to understand the coupled human–environment system in ways that are useful to the different communities of stakeholders involved. A fundamental part of sustainable development is community development.'A concern for many of these communities is an improved understanding and projection of the vulnerability of people, places, and ecosystems in the face environmental change' (Turner II. Et al., 2003).

According to Sing (1997) 'sustainable development like development is a dynamic concept, constatly refined in relation to nature and society'. Keeping in mind controversies regarding its definition (Beck, U, 1986, Sunstein, C, 2002) and its ambiguous nature, in todays world (Sing, 1997) sustainable development means 'equitable development that: (a) does not exhaust non-regenerable resources, (b) maintains an ecological balance in the production of wastes an goods, and (c) takes into account the renewability of natural resources'.

The UN/ISDR conceptual framework places vulnerabilityand the disaster risk reduction elements within the “sustainable development context” (Figure 3). Risk reduction strategies should promote sustainable development by making the best use of connections among social, economicand environmental goals to reduce risk (UN/ISDR, 2011).

2.5. Perception of risk

According to Armas & Avram (2009) vulnerable communities' perception of risk is 'an essential link in the analysis of man–environment coping relationship and also an important parameter in the quantification of complex vulnerability as a central predictive variable inthe risk equation'.

Risk perception is a subjective assessment of the probability of a hazard happening and how concerned people are with the consequences, it goes beyond

the individual, and it is a social and cultural construct reflecting values, symbols, history, and ideology. Two distinct theories currently dominate the field of risk perception: (a) psychometric paradigm (Slovic, p. 1987) developed by psychologists and decision making scientists and (b) cultural theory, developed by sociologists and anthropologists (Sjöberg L. et al 2004).

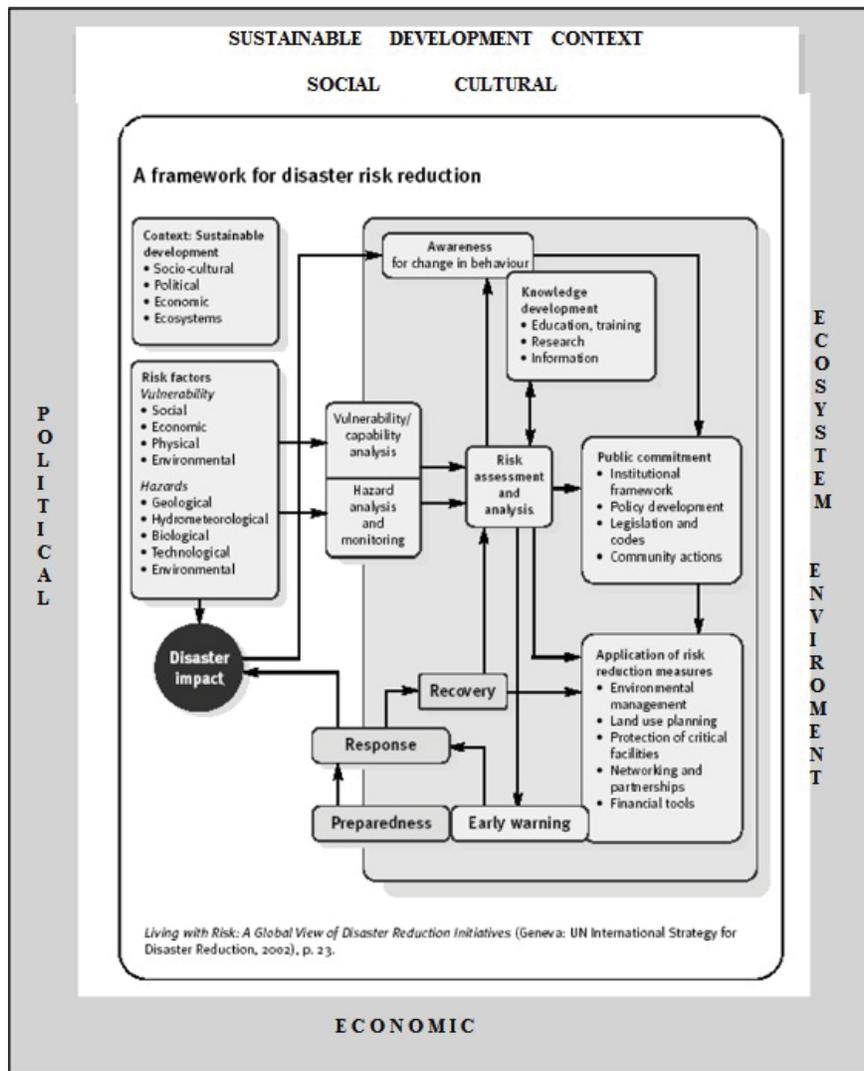


Figure 3. UN/ISDR(2002) framework for disaster risk reduction in a sustainable development concept

Within the psychometric paradigm, people make quantitative judgments about the riskiness of diverse hazards and the desired level of regulation of each. These judgments are then related to judgments about other properties, such as (i) the hazard's status on characteristics that have been hypothesized to account for risk perceptions and attitudes (for example, voluntariness, dread, knowledge, controllability), (ii) the benefits that each hazard provides to society, (iii) the number of fatalities caused by the hazard in an average year, (iv) the number of fatalities caused by the hazard in a disastrous year, and (v) the seriousness of each death from a particular hazard relative to a death due to other causes (Sunstein, 2002).

Numerous studies carried out within the psychometric paradigm have shown that perceived risk is quantifiable and predictable (Sunstein, 2002). Psychometric techniques seem well suited for identifying similarities and differences among groups with regard to risk perceptions and attitudes. During the development of the psychometric paradigm, cultural factors have been taken into consideration.

In a review of 20 year of research of risk perception Boholm (1998) concludes that risk perception comparative studies 'tend to subscribe to the psychometric paradigm' forming a herterogenous field of research, which needs to be further refined, both methodological and theoretically.

Morrow (2009) underlines the importance of: psychometric paradigm (focusing on psychological factors that influence risk perception), cultural risk theory (focusing on the effects of social and cultural norms and experiences), the mental models approach (emphasizing the images of reality we carry in our head and apply when interpreting new information), and the social amplification of risk perspective (how risk is amplified or attenuated by the channels and processes it goes through) which can contribute to a better understanding of the complexities of risk perception.

Cultural theory offers a constructionist and structural perspective on risk and proposes that distinct patterns are discernible in cultural constructions of risk and that these are closely related to cultural worldviews and 'myths of nature' (Burkell, K, 1998). He presents four types of prescribed behaviour: fatalist, egalitarian, hierarchist, individualist, corresponding with the 'myth of nature' (nature capricious, nature perverse/tolerant, nature ephemeral, nature benign).

3. New Ecology

The debate in ecology that disputes notions of balance or equilibrium in nature started about 70 years ago. In his famous textbook of 1930, Elton noted that "the balance of nature does not exist and perhaps never has existed" (Elton 1930, apud Scoones I. 1999). Connell & Sousa (1983) advance the issue very clearly when

stating: "If a balance of nature exists, it has proved exceedingly difficult to demonstrate." Despite such observations, however, the science of ecology, over much of this century, has been built on equilibrium notions, ones that assume stasis, homeo-static regulation, and stable equilibrium points or cycles (Scoones, I, 1999).

The balance of nature idea and the classical equilibrium paradigm have had profound influences on applied ecology, especially on nature conservation, as they have led to the supposition that 'nature knows best' (Wu J. & Loucks, 1995). The landscape ecology, promoted by the new ecological thinking integrates conflicting paradigms about nature and considers nature as being intrinsically non-linear.

According to Seuront (2010) scale is undoubtedly one of the central themes of landscape ecology. Most of the landscape properties playing a role in the biology and ecology of populations change with changes in scale. 'The notion of scale is quite broad and involves a wide range of terms and concepts that can be clustered under key categories such as heterogeneity, hierarchy, and size.

The first one (heterogeneity) includes spatial patchiness and temporal variability, and has been acknowledged as an essential property of nature. The second one (hierarchy) is an intrinsic property of ecosystems, which are always hierarchically organized, and this implies the consideration of an organizational scale' (Seuront L, 2010).

Landscape ecology and the following concepts seem to be at the core of the 'new ecology': (1) Non-linear systems with more than one equilibrium attractor (Noy-Meir 1975) (2) Recognition of chaotic dynamics (Hastings et al 1993, Seuront L, 2010); (3) Stochastically dominated systems that are truly non-equilibrium (Seuront L, 2010).

Hierarchical Patch Dynamics (HPD) (Wu J. & Loucks, 1995) is one of the most satisfactory conceptual framework that links all new ecology concepts and its most important contribution is the fact that 'incorporates heterogeneity and scale and integrates equilibrium, multi-equilibrium and non-equilibrium perspectives'.

Landscape ecology is an interdisciplinary field that aims to understand and improve the relationship between spatial pattern and ecological processes on a range of scales (Wu, J. 2011). The term was coined in Europe in 1939, but landscape ecology was not recognized until the 1980s, when remote sensing data became widely accessible to ecologists and geographers. In Europe, the landscape ecology perspective has been characterized by a 'holistic, humanistic, and society centered view of landscapes' aiming to link the gap between nature and society (Wu, J, 2011).

New models have been developed to take account of fundamental new ecology concepts: (1) variability of space/time; (2) Spatial patterning of ecological processes from small scale patches to broader landscapes; (3) Importance of non-equilibrium dynamics in a variety of settings, recognition and importance of temporal dynamics (Scoones, 1999).

The term 'chaos' implies the existence of unpredictable or random behavior. Chaos theory was applied by Edward Lorenz in his meteorological work (1963), and in the last 40 years has been applied to many natural sciences. The discussion started from the reconsideration of the Newtonian paradigm that certainty, linearity and predictability are the essential elements of the universe (Kiel, L. D. 1996).

According to Kiel (1996) social scientists are trying to incorporate theory and method from the natural sciences and chaos theory in social sciences appears to provide a means for understanding uncertainties, non-linearity and unpredictabilities inherent to social systems. It also seems to be bridging the gap between social and natural sciences.

'Life is nonlinear' (Pagel, H R, 1988) as well as nature, human actions and decisions. Disaster situations are particularly interesting because of their inherent non-linearity.

4. Conclusions

This paper aims to create a new understanding on the current complexity of concepts regarding vulnerability and risks to natural disasters, adaptation and sustainability. We aimed to show the connections between very different concepts from natural and social sciences. Society and nature cannot longer be approached in isolation.

A brief summary of the papers' main points are:

The first part of the paper risk (Beck, 1989) is the central organizing concept in a post-industrial society, which he calls risk society. Although the risk society is a profoundly innovative theory explaining risks at the level of our global society it has its limitations: assumes that life in modern societies has become more risky; the risks of the past are different from the risk induced in the modern society and vulnerability is produced and increased by disasters.

To address these limitations the authors tried to bring together two different approaches such as Blaikie's situational approach, which demonstrates that social vulnerability and diversification of risks are the causes of disasters and Morrow's empirical approach demonstrating an unequal access to opportunities and exposure to risks, which are consequences of socio-economic systems, in both poor or wealthy countries.

In the subchapter presenting vulnerability the authors stressed the lack of agreement on the meaning of disaster or vulnerability, which is not unusual for the scientists of this century to encounter such a problem as long as definitions are followed by appropriate use of methodologies and systematic research.

Therefore studies should state a definition of vulnerability, the level of the approach (global, situational, empirical, etc) in order to make explicit the

theoretical concept used because the choice of the definition leads to a specific type of vulnerability analysis.

From Bohl (2001) comprehensive presentation of vulnerability the author show that knowing the components of vulnerability is important, but more important is to understand the interactions between different internal and external components.

The adaptation sub-chapter deals with variability of adaptation due to environmental, economic, political, and cultural conditions emphasizing Moran's (2000) ecosystem approach, which helps develop explanatory models of human behaviour.

The authors chose a sustainable development approach of vulnerability emphasizing the importance of understanding the projection of the vulnerability of people, places, and ecosystems in the face of current and future environmental change raising issues such as equity.

The chapter on risk perception shows the importance of this parameter 'in the quantification of complex vulnerability as a central predictive variable in the risk equation' (Armas & Avram, 2009)

Conventionally there is a lack of articulation between natural and social sciences and, in order to overcome this barrier this paper aims to look at a conceptual common ground bringing together concepts such as: risk, vulnerability, adaptability, sustainability, new ecological thinking.

Landscape ecology with Hierarchical Patch Dynamics framework (Wu J. & Loucks, 1995) links all new ecology concepts and its most important contribution is the fact that 'incorporates heterogeneity and scale and integrates equilibrium, multi-equilibrium and non-equilibrium perspectives applicable to both society and nature. Furthermore, new ecology thinking presents the non-linear, chaotic nature of natural events such as disasters.

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