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HUMAN COPING WITH RISK

Using actor-systems-dynamics theory as a basis for the understanding of the way societies deal with environment

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HUMAN COPING WITH RISK

USING ACTOR-SYSTEMS-DYNAMICS THEORY AS A BASIS FOR THE UNDERSTANDING OF THE WAY SOCIETIES DEAL WITH ENVIRONMENT

Abstract

This report presents the bases for a theory designed to comprehend human patterns of coping with risk. First, risk notion is framed on the duality society-environment and its comprehension is exercised in the light of actor-system-dynamics theory of Burns (2006; 2007a) and Social Rule System Theory of Burns and Flam (2000). Afterwards, a discussion and definition of core concepts of this proposal will take place, respectively: risk, vulnerability, resiliency and disaster. Finally, the most common forms of human coping with risk will be briefly identified.

This paper was developed under PhD program on sociology at Instituto Universitário de Lisboa-ISCTE.

ADAPTAÇÃO HUMANA AO RISCO

TEORIA DINÂMICA-ACTOR-SISTEMA COMO BASE PARA A COMPREENSÃO DO MODO COMO AS SOCIEDADES LIDAM COM O AMBIENTE E SEUS EXTREMOS

Resumo

Este relatório apresenta as bases de uma teoria orientada para a compreensão dos padrões de adaptação humana a riscos ambientais. Começa-se por enquadrar a noção de risco na dualidade sociedade-ambiente, alicerçando a sua compreensão na teoria da dinâmica-actor-sistema de Burns (2006; 2007a) e na teoria dos sistemas de regras sociais de Burns e Flam (2000). De seguida, procede-se a uma discussão e definição dos conceitos nucleares desta proposta, respectivamente: risco, vulnerabilidade, resiliência e desastre. Finalmente, procede-se a uma identificação das formas mais comuns de adaptação humana a riscos, *designadamente aqueles induzidos por fenómenos extremos ambientais.*

Este texto foi elaborado no âmbito do Programa Doutoral em Sociologia do Instituto Universitário de Lisboa-ISCTE.

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1. Introduction

Statistics on disasters induced by environmental extremes, along the twentieth century to the present day, reveal a tendency for an increase of its frequency and impacts. Indeed, according to Munich-Re data (2006; 2007), hydroclimatic phenomena, such as floods, storms and hurricanes, suffered an increase, at least since the 1950s, while geophysical extremes, such earthquakes, maintained constant in time. This increase was, in turn, accompanied by a worsening of socio-economic impacts and costs.

Such trend is, in our view, revealing of a contradiction. In nowadays, scientific knowledge of physical environment processes, its variability and extremes, is exponentially higher than any other period in human history. On the other hand, societies have presently at their disposal much more means and alternatives, thanks to accumulated knowledge and technology, to better cope with environment and its extremes. Nevertheless, disaster impacts continue to rise.

This contradiction is interpellant of the relation modern societies maintain with their environments. Concomitantly, it questions our vision and ways of coping with risk. Modernity was mainly dominated by a physicalist vision of risk. This was specifically acute in the case of the so-called natural risks. Its causes were unquestionably outside social realm and on physical environments. This set the stage for the societal relying on physical sciences and engineering as a prime way of uncovering geophysical processes underlying extremes and control nature. The increase trend of such events and, more importantly, the evidence of an intensification of its consequences, show clearly how erroneous is to keep society out of risk analysis. From the scientific point of view, it is evident that physical sciences *per se* don't furnish a more cabal understanding of the complexity underlying such phenomena and that social sciences can give a valuable contribute.

The purpose of this paper is to provide a basis for a theoretical framework designed to approach human patterns of coping with risk. It is, consequently, a paper where the main preoccupation is to define the core concepts on which the understanding of human coping with risk should stand. From our point of view, risk results from the interplay between society and environment. Consequently, any exercise of understanding such phenomena, in the context of modernity, should start by this duality. In this paper, we approach and discuss this duality in the light of Actor-System-

Dynamics theory of Burns (2006; 2007a), Burns et al (2007b), and Burns & Flam Social Rule System theory (2000). A reflection around this problematic cannot, in our view, escape from a discussion around the risk concept, with the main aim of defining our position about it. This discussion opens a reflection around the patterns of human coping of risk and some of factors that may explain variability.

2. The triangle social structure-agency-environment

Physical environment and society are both implicated on risks, its causation and magnitude. Thus, it is misleading to envisage them as some kind of exogenous phenomena that occur elsewhere in the physical world. Refusing such presumption implies to stand the comprehension of risk processes on the ebb of relations societies maintain with environment.

It is presently well diagnosed that, for long, sociology refrained from systematically considering physical environment when theorizing about society and modernity. In short, we could say that it resisted getting out from the frontiers of social structure-agency dichotomy and debate. The inversion of such tendency remounts the late 1960s and is not foreign to social experience of environmental disaster which uncovered the pernicious effects of human interactions with environment, in the context of modernity.

But, the recognition of such limitation doesn't imply "to start all over again". Sociological theory furnishes the basis for the comprehension on the way humans behave, interact, and organize themselves and such basis is fundamental for an understanding of human agents' dealing with their eco-social contexts. As mentioned earlier, our theoretical reflection around the dynamics between social structure, human agency and environment will stand on the contributions of Actor-System-Dynamics theory of Burns (2006; 2007a), Burns et al (2007b), and Burns & Flam Social Rule System theory (2000).

It is important to start this reflection by emphasizing that society and environment are not two separate *things*, with clear boundaries. Instead, physical environments are an integral part of the organization of societies. The relationship between both is of mutual molding. Eco-systems are a source of constraint and simultaneously of opportunities to human agency. On the other hand, along the process of taking advantage of material conditions and nature resources, human agents

transform eco-systems and natural processes (Burns et al., 2000; Bates et. al., 1994; Bolin et al, 1998). Societies are, consequently, open systems, engaged on exchanges with physical, biological and their sociocultural underpinnings. This characteristic of openness and mutual molding send us to Adger (2006) definition of social-ecological system. Eco-systems refer to biological and geophysical processes while social systems are made up of networks of units, regulated by rules and institutions that mediate human use of resources as well as systems of knowledge and ethic that interpret natural systems from human perspective. Bates et al. refers (in ibid) to the interplay between humans systems and their environments as interactive, changing in the relationship with each other in a kind of evolutionary process.

The postulate of physical environment as a source of constraint and simultaneously of opportunities for human action should be emphasized. Risks are examples of constraints posed by (usually modified) environments. In actor-system-dynamics theory, physical environments appear, jointly with social structures, as major forces of constraint and facilitators of the actions and interactions of human agents. Physical environment operates selectively on human groups, determining which actions can be pursued, as well as sustain human activities, providing the resources necessary for life and material development. Social structures regulate agents and their interactions, by constraining and simultaneously facilitating human initiative and transformation capability.

Human systems and agents interactions with their environments renders concrete through adaptive processes. These refer to forms of social organization in order to cope with constraints as well as to surpass them. Indeed, as Burns et al (2000) refer, human agents are reflexive and consequently capable of surpassing constraints imposed by their environments. In the context of modernity, technology, embedded on socio-technical systems and knowledge, plays an irreplaceable role, by providing adaptive mechanisms towards eco-systems. Nevertheless, it should be emphasized that such adaptive processes may take different courses or assume different facets. Social systems can show great adaptive capacity on their ability to use vast amounts of natural resources and by converting them into products and services. But such adaptation can be at the expense of a decrease of sustainability towards environment or may induce new constraints, exacerbate vulnerabilities and create breakpoints in resilience of socio-ecological systems (Bates et al, 1994; Folke, 2006).

Clancey (2006, pg.1-2) research on the history of Japan patterns of coping with earthquakes, during the late 1870s, illustrates the complexity underlying adaptive processes. In this period, after

the Meiji Restoration, a process of "technology transfer" and embodied knowledge took place through the arrival of architects and engineers from the Occident with the main aim of teach and alter building construction methods and practices in Japan. Wooden-country Japan, it was decided, would be rebuilt in masonry and iron. The existing architecture and traditional building methods were considered as old-fashioned and fragile, by comparison with brick and stone which symbolized strength and modernity. Meanwhile, on October 28, 1891, one of the most powerful earthquakes in modern Japanese history occurred, affecting Nõbi Plain, north of Nagoya. Most of the large iron bridges, wall of brick factories and buildings, symbolizing foreign and modern knowledge and technology, crash down, while Japanese temples, pagodas and architectural monuments such as Nagoya Castle escaped. This piece of Japanese history illustrates the contradictions that may underlie adaptive processes. They may be effective to certain societal aims and demands, but pervasive, and even regressive, concerning others. Nõbi earthquake experience stimulated a process of social learning and re-organization of architecture and engineering practices. Basically, Japanese were forced to question foreign knowledge and readapt it, by incorporating traditional knowledge and building practices.

According to Burns et al. (op. cit) theory, human activity is regulated and organized by socially (re)produced rule systems. These correspond to written norms, i.e. laws, technical regulations, administrative procedures as well as non-written principles embodied in traditions, codes of behavior and habits. They play a crucial role of conferring sense to social practices, empting everyday life from uncertainty and turning it predictable. As forms of practical knowledge collectively shared, rule systems not only guide social actors' behavior as well as allow them to interpret and anticipate other actors' action on the multiple stages and circumstances of everyday life.

Rules and rule systems mediate the relation between social structures and human agency. Social structures correspond to institutions (i.e. governments and government agencies, markets and business organizations, family, and religious communities) and cultural formations based on rule complex systems (Burns, 2007a). These have attached rules which not only confer sense and orientate interactions, but also assign roles, procedures, and legitimate actors to occupy particular positions, with specific responsibilities, power and autonomy of action. But, it should be emphasized that social structures and underlying rule systems are not some kind of super-entity. Indeed, they introduce constraints to human action, but also opportunities to pursue certain actions that, otherwise, would be difficult or even impossible to implement (Burns, 2007a). On the other

hand, social actors are reflexive agents. They may act in conformity with the rules, but also enjoy of certain degrees of power or autonomy to ignore, resist or change the conditions of action and underlying principles and rules. Social structures and rule systems regulate and are at the same the product of human action.

By mediating the relation between social structures and agency, rules and rule systems also mediate the relation between social structures, agency and their underlying environments. Social interactions with eco-systems are generally oriented by a set of principles and rules. These can be of informal nature, deeply embedded on routines and habits of human agents, or of formal order. An example of formal rule systems (or rule regimes) is the large array planning instruments, i.e. environment policy plans, land-use plans, coastal zone plans, intended to regulate, organize and control human activity towards environment.

Given this, rule systems are, jointly with technology, what links and mediates the relation between societies and their material environments. Both are both the vehicle and the product of adaptive processes towards environment.

But, as Burns et al (op cit) postulate, not every aspect of human activity is regulated by rule systems. There can be *arenas* of social life not specifically organized by rules and, consequently, open to *ad hoc* actions or activities solely motivated by human agents motivations and interests. On the other hand, rules never specify or regulate at the exhaustion human action. Consequently, not every social patterns of life or human behavior are explainable and understandable in terms of rules. Situational conditions may impede the reproduction of rules or even be at the basis of processes of social change. The example of Nõbi earthquake, referred above, is illustrative of situational and environment-related events which induce on re-organization of action.

3. Risk and patterns of human coping

3.1 Risk, vulnerability and resilience

In the context of modernity, the conceptualization of risk evolved from a naturalistic format to an increasing anthropogenic format and from an objective perspective to a constructivist one.

In its older usage, the term risk meant an objective danger embodied by a natural phenomena or event (Strydom, 2002). In its modern usage, the term risk not only enlarged its spectrum, by integrating the so-called technological risks, but also reinforced its objective character. By being transformed into a privileged object of science, risk became to mean "the likelihood, or probability, of some adverse effect of a hazard" (Short, 1982), multiplied by the magnitude of loss. Its objective character was given by the ability of, through scientific calculus, transforming risk into a quantity that could be measured quite precisely by the means of a formula (Strydom, in ibid).

This concept of risk embodies the so-called, and still dominant, physicalist approach to natural hazards. According to this view, environmental extremes are mainly envisaged has events where human action has no part on its causation, but geological, hydrological and meteorological processes. As Hewitt (1983) posits, the sense of causality or the direction of explanation is primarily, and exclusively, on the physical environment[1]. The counterforce to nature irreverence rests on physical sciences and technology, who is supposed to furnish expertise knowledge and physical artifacts for monitoring, forecasting and modification of natural processes. Such approach reflects, in turn, a historically specific view of environment and society, where nature was ideologically and materially commoditized and an object to be controlled and social systems as separate entities from their environments.

By being exclusively concerned with geophysical processes, geophysicalist paradigm drove attention away from social factors embedded in risk causation and effects. It treated them as exogenous phenomena, de-contextualized them from the social fabric and human-environment relationships. The questioning of physical and "un-natural" attached to the so-called risks, and natural hazards, is at the basis of the emergence of an alternative paradigm. This paradigm reunites a diversity of approaches once it has been nourished by an array of views and proposals from ecology sciences to social sciences. Nevertheless, one can say that they all share the assumption

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[1] Indeed, few researchers would deny that social factors and habitat conditions affect risk and its effects. But, as Hewitt (in ibid, pg. 5) emphasizes, the representatives of dominant view relegate such factors to a dependent position and attribute the initiative of disaster to geophysical processes and advocate the importance of controlling such processes through managerial activities and technological devices, such as flood control works, cloud seeding, or avalanche defenses. Social sciences also contributed to the social reproduction of such dominant view mainly due to their resistance on equating human-environment relations in a systematic way and tendency to envisage societies as isolated systems, separated from their physical underpinnings.

that risk results from the interplay between ecological and social systems and is mediated by social processes that may amplify or, on the contrary, attenuate risk probability and magnitude.

Social sciences approach to risk and disaster issue is marked by fragmentation and lack of synergies either between scientific branches or theoretical perspectives[2]. This is not the place to go deeper on the reflection around the configuration of social science *risk archipelago*. What seems important to emphasize is that, on the realm of social sciences, the concept of risk and disaster evolved from an objectivist perspective to a constructivist one. Social science research developed from the middle 1950s to the 1980s maintained unquestioned the physical-agent conceptualization of disaster and centered its interests on the study of patterns of human response towards hazards and crisis behavior. White (1945) and Burton et al. (1978), drawing on human ecology, drove attention away from response and crisis period and channeled their interests to human factors that create or modify human exposure towards risk and hazardous environments. But, by anchoring explanation solely on individuals' bounded rationality and consequent misinterpretation of nature and its extremes, these geographers left unquestioned social influence on risk causation as well as the role of social structures in shaping differential exposure towards hazards. This issue is later raised by Blaikie et al. (1994) who define risk as resulting from a complex combination between hazard and vulnerability, which is envisaged as a product of social processes that generate differentiated patterns of human exposure towards risk. Social constructionism applied to environmental risk remounts Douglas et al. (1982) research on the processes of cultural selection of

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[2] Disjunctures reveal themselves at least at three levels. The first level is of disciplinary order and reflects a surprising disciplinary inability to dialogue and interdisciplinary work among social sciences, which doesn't favor the construction of an integrative theoretical framework nor the dialogue with physical sciences. Instead of presenting one solid, although multidimensional, theoretical input to an alternative paradigm, social sciences presents themselves with parceled fragments of knowledge prone to confusion for who is not from the field. The second disjuncture concerns the lack of interconnectivity between disaster studies, and natural hazards perspective, attached to human geography, which became an inspiration and influence to many researchers working on risk analysis (Krimsky and Golding, 1992). A third disjuncture sends us to approaches concerned with the problem of the so-called natural hazards and approaches centered on technological risk issues. White (1988, pg.172) compares these two fields to two streams in "roughly parallel courses in an alluvial valley. They touch here or there, and sometimes join each other during high water, but for the most part they are separate, with few direct connections". According to White, the circumstance of having borne under different scientific disciplines may have been a factor. But, while among physical sciences such duality may theoretically and epistemologically make sense — geological processes and earthquakes are to be studied by geologists and seismologists and toxic substances a domain of expertise of biology — in social sciences such separation may not make sense. Almost all hazards have natural or environment-related components and human-induced or technological components. On the other hand, the study of how risk in socially perceived and dealt in the course of social life and action towards environment, research on factors underlying societal choices and variability in terms of risk acceptability, are not only matters of common concern between researchers of both "streams" but may also have similar configurations.

technological dangers and gained prominence on the realm of environmental sociology. Dickens (1996) emphasizes that nature doesn't speak by itself. The assumption of certain phenomena as environmental problem is socially produced and discursively constituted. Hazards only gain the configuration of risk when socially communicated and object of a social process of meaning. On the other hand, human action towards risk requires its selection as object of social concern and its salience among those at risk (Bolin et al, 1998).

In our view, the most appropriate conceptualization of risk is the one that surpasses the limitations of objectivist definitions and avoids the excessive relativism of constructivist approach. Risk has inherent something real, materialized in possibility of occurrence of a perturbation or stress, with undesirable consequences to human systems. But, since physical environment doesn't speak by itself, the identification and assertion of certain phenomena or human activity as source of hazard implies it social construction as a risk. Furthermore, social systems interfere on risk causation, probability of occurrence and magnitude, either on the direction of its amplification or attenuation. The concepts of vulnerability and resilience intend to translate such variability, in time and space and accordingly to the patterns of social structuration and human relationship with ecological systems.

Vulnerability refers to the degree to which a system, social group or individual is likely to experience harm due to exposure to a hazard (Blaikie et.al, 1994; Adger, 2006). There is no risk if there are hazards but the vulnerability is nil; or if there is a vulnerable population but no hazard.

According to Blaikie et al (in ibid), vulnerability is socially produced and rooted on complex social, economic and political forces that structure people's everyday lives, their choices and options in the face of environmental hazards. Such view transcends the common definition of vulnerability which takes solely into account the physical characteristics of built environment, urban landscapes and buildings. Nevertheless, we should not ignore that urban landscapes are also the material expression of political, economic and social forces that shape differential degrees of susceptibility towards hazards.

Blaikie and colleagues theoretical framework emphasises the social structure as a major source of constraint and vulnerability. Patterns of susceptibility towards environmental hazards have on its basis "root causes", which are general historical, political and economic factors that produce unequal distribution of power and resources among people, often according to gender, class, race, ethnicity and age. Such "root causes", in conjunction with "dynamic pressures" – e.g. rapid

urbanization, environmental degradation, political conflicts, and economic crisis – generate "unsafe conditions" under which some individuals in a given place must live (Bolin et al, 1998).

As mentioned on the previous chapter, we envisage social structure, jointly with physical systems, as a source of constraint of social interactions and material developments. Nevertheless, social structure may also act as a facilitator of opportunities and change, namely in what concerns to the improvement of resilience towards risk. On the other hand, individuals and collective agents are not just object of structural and material constraints, but can also act creatively and enjoy of certain degrees of autonomy to reshape the conditions of their actions. In this sense, they may at certain extent interfere, either negatively or positively, on their own susceptibility towards risk.

Aguirre (2007, in press) proposes to envisage vulnerability and resilience as part of a dialectic process, taking place in time and space. Vulnerability grows as it decreases social investment on resilience and vice-versa.

Resilience is, in turn, currently defined as the ability of human communities to withstand disturbance, induced environmental extremes and/or by unintended effects of human action. The ability to absorb disturbance is, in great part, given by social structure, institutional arrangements and human agents' adaptability capacity, that is their ability to anticipate risks, integrated them in the course of their action and re-organize the patterns of interaction with environment. Given this, besides robustness towards disturbance, resilience also encompasses system's capacity to take advantage of past, on-going or future disturbance and promote change in the direction of an increase of social-ecological adaptability (Folke, 2006; Adger et al. 2005; Aguirre, in ibid).

As any other arena of human social activity, adaptability towards environmental hazards is achieved through rule processes. Social rules and system of rules that render possible the integration of risk in the course of human action towards environment can be of informal nature or assume the form of *rule regimes*. The first correspond non-writen rules, generated and reproduced through social experience[3]. *Rule regimes* refer to institutional rule processes materialized into risk mitigation public

[3] The reaction of fishing communities of Simeulue Island, by occasion of 26th December Asian Tsunami, in 2004, is a good example of adaptability processes anchored on informal rule systems. This island is located in west Sumatra and close to the epicenter of the earthquake that caused the tsunami. Surprisingly, there were almost no casualties and this was attributed to people immediate reaction of running to the hill, mountain or other highly located places, instead of running to the sea or rivers to collect fish, at the moment of wave' retreat. Such protective behavior is attributed to a story, deeply inscribed in Simeulue folk culture and transmitted from generation to generation. This story send us to an earthquake that took place in the island, by the year of 1907, generating a tsunami that swept away Simeulue western beach area resulted

policies designed to organize, control, and regulate human activity and behaviour towards environments. In the context of modern societies, technology and scientific expertise is, jointly social rule systems, irreplaceable for resilience purposes.

3.2 Disaster as a process

Disasters are currently, and unquestionably, defined as discrete events, or severe occurrences that impinge over a social system and induce on losses to its members and physical appurtenances. As Hewitt (1983) emphasises, in the language of discourse disasters, particularly those triggered by natural agents, appear as unprecedented phenomena, caused by some kind of sudden and unexpected exogenous force. This vision of disasters gives the sense of discontinuity or otherness; as if they were somewhere out of the rest of man-environment relations and social life.

The main problem of this definition resides on the erroneous placement of disasters outside the realm of ongoing social order, its everyday relations with the environment and the larger historical circumstances that shape or frustrate processes of adaptability and resilience. Most natural hazards are more expectable and knowable than it is presumed. Besides, in the context of modernity, they became increasingly endogenous to societies due to a huge process of socialization of nature (Giddens, 1998).

According to Bates et al (1994), disasters occur when one or more of the sociocultural systems fail to provide an adaptation to the environmental conditions, necessarily variable in time and space, or when one of these systems produce, from within his own order, an event that threatens population. Given this, the problem of understanding should shift from the pure physicalist dimension to the understanding of relations between particular types of human systems and their environments.

This assumption is at the basis of a shift from the conceptualization of disaster as an event towards its conceptualization as a process (Hewitt, in ibid; Oliver-Smith, 1998; Bolin et al, 1998). Disasters that can follow a geophysical extreme should be understood as reflecting the on-going patterns of social structuration and certain patterns of socially produced vulnerabilities. By this, there is no

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in huge human losses. People of the island called this tsunami a *smong*. *Smong* story was then told repeatedly by the elders to their children, the first remembering the youngsters that whenever a big earthquake take place, it may followed by water retreat to the sea, and in face of this they should not wait and bring their belongings, but run to highly places (Adger, 2005; http://www.unisdr.org).

intention of denying geophysical physical processes underlying disasters, but to place disaster inside the responsibility of society and broader historic processes of man-environment relations.

Folke (2006) states that, in the context of adaptive renewal cycles, "disturbance is part of development". Assuming the so-called natural disasters as examples of disturbance, we would precise by stating that disturbances of this sort take part of sociocultural evolutionary processes which do not necessarily lead to development, in the traditional terms of the word. As mentioned before, disasters signal a deficit of social-ecological adaptability. Indeed, experience of disaster provides opportunities of social learning, of innovation, and change of institutional arrangements and rule systems in a way that increases adaptability towards environment and resilience. Nevertheless, a perpetuation of previous patterns of vulnerability, or even its worsening, may also occur.

3.3 Patterns of human coping with risk

Societies and human agents act differently towards environment and its underlying risks. Their way of coping with risk can range from "doing nothing", and bear disaster impacts, to act pro-actively, by structuring and regulating social practices and interactions with environment in a way that it eliminates threat or/and increases its robustness towards eventual disaster impacts.

In our view, it belongs to social sciences the uncovering of social patterns of human coping with environment and its extremes, as well as the factors underlying different patterns of human coping with risk and its effects. What inherent to social structures, cultural formations, human action and material practices is at the basis of the reproduction of poor adaptability towards environment and its extremes or, on the contrary, what stimulates resilience?

The way societies and human agents cope with risk is largely dependent of social experience of risk. As Kasperson (1992) posits, experience of risk is both experience of physical harm and the result of culture and social processes by which human agents acquire, create and reproduce representations of environment and its extremes. Threats and hazards remain un-named and un-represented if have no place on language-based collective representations and communication. Such collective representations play, in turn, a major role in the shaping human consciousness (Burns, 2006) towards risk. Human consciousness provides self-reflectivity and insight of whether human agents are willing to live with threat or predisposed to invest in the reduction of risk they believe they are exposed to.

Experience of physical harm feeds social memory. Social memory concerns the history of social system, namely towards environment and its extremes, which provides context and sources for social reproduction but also for re-organization. Indeed, although usually treated as a footnote when they are not more than a presumption, disasters may, when they occur, become catalysers of change. They allow social learning which can revert on change of rule systems underlying man-environment interactions.

As emphasised earlier, social systems interaction with environment is mediated by rule systems. Human agents create and utilize rules in order to render possible a large array of social practices physically inscribed. Such rule systems result from a continuous process of feedback between social systems and the physical world as well as reflect human agency creativity. As Burns states (2006), eco-systems pose constraints and operate selectively on human groups, determining which rules can be realized in practice and what modifications should be introduced in order to gain more effectiveness. Environmental risks, and their expression in the form of disaster, are illustrative of such constraints. Even though, environmental constraints are not fixed, in time and space, and can, at certain extent, be surpassed through human agency. In the context of modernity, science and technology, embedded in socio-technical systems, are crucial means of surpassing limitations imposed by the physical world (Burns et al, 2000).

Given this, in their role of linking social systems to physical environments rules become important units of analysis as far as it concerns to knowledge of the processes of human adaptability towards risk and environmental extremes. In short, rules reflect certain patterns of adaptability and are, at the same time, irreplaceable vehicles of fostering adaptability capacity.

Globally, adaptive capability is a function of the degree of societal investment on two parameters of the so-called hazard cycle[4] — risk mitigation and emergency preparedness. The first parameter concerns human action taken during routine day, long before an uncertain event, aimed at

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[4] The concept of hazard cycle denotes the four temporal stages associated with risk and its expression in the form of disaster, respectively: mitigation, preparedness, response and recovery. Mitigation involves human action, taken along everyday life, to decrease vulnerability and provide passive protection during disaster impact. Emergency preparedness encompasses actions directed to enable social units to respond actively when a disaster strikes. Emergency response consists of actions taken a short period prior to, during and after disaster impact. Post-disaster recovery comprises actions taken to repair, rebuild, and reconstruct damaged properties and to restore disrupted community social routines (Tierney, 2001).

reducing risk as well as decreasing its potential impacts of a disaster. Notwithstanding, as mentioned earlier, post-disaster recovery processes may turn on opportunities on investment of risk mitigation.

Emergency preparedness, on the contrary, involves activities specifically concerned with turning the future as much predictable as possible. Routine is, jointly with social rule systems collectively shared, what confers stability and reduces uncertainty to social interactions and practices. Disasters provoke disturbance and disruption of social routines. In this sense, the anticipation of the demands posed by an eventual perturbation, in the future, and the improvement of human agents' capability to respond in a timely and effective manner to an impending threat, has the ability of turning such uncertain future events less unpredictable and disruptive (Lindell, 1997). Advanced emergency planning and plans consist, in great part, on processes of rule system making where organizations and its representatives establish "who does what, when, in coordination with whom and with what resources" in case of a future and uncertain disruption.

In sum, risk mitigation and emergency preparedness render concrete through the implementation of rules and rule systems, designed to organize human behaviour and activities in environments previously recognized as prone to certain hazards. Such rule systems may be of informal order or formal nature. Formal rule systems correspond, in practice, to public policies, embedded in institutional arrangements to which is given authority and power to influence or even force the application of rules and regulate human activity physically inscribed.

In the context of modernity and western societies, science and technology are deeply intertwined with politics and policy-making (Burns, 2007a), and this is especially acute in the domain of risk management.

In schematic terms, risk mitigation usually follows two types of approaches: one aimed at modifying physical hazard agent and another one aimed at reducing patterns of vulnerability and human exposure towards environmental hazards. A typical example of the first type of approach is the use of engineering methods to keep hazards such as riverine and coastal flooding away from people and damageable property. Dams and flood storage reservoirs, levees, dikes, pumps, channel improvements and diversions, sea walls, and groins, gained a character of ubiquity in modern industrialized societies, with the main aim of modifying the nature of flood hazard and simultaneously allow human occupation of landscapes and exploitation of its resources (Burby, 1998). Strategies of this sort illustrate human capability of, through technology, surpassing

constraints imposed by physical environments. But, as Burns (2000) emphasises, human activity is not exempt of unintentional effects and new constraints. Structural hazard reduction strategies, as the ones directed to flood control, usually don't eliminate risk, but transform its nature and may create others[5]. Risk reduction anchored on strategies of abatement of vulnerabilities towards risk presupposes the previous societal recognition that human agency interferes on risk causation and magnitude, turning imperative its regulation. Such aim is achieved through social rules systems aimed at controlling human activity physically inscribed. In the context of modern industrialized societies, this approach is usually rendered concrete through *rule regimes*, in the form of public policies, directed to regulate development on hazardous areas and/or to promote safe construction. Once again, this is a type of strategy that requires expertise knowledge and challenges science-policy interface. Risk analysis and assessment is a fundamental basis of support of decision making as well as engineering methods, this time not so moved by the ideal of controlling nature, but on promoting a more adequate cooperation with environment and its extremes.

Similarly to risk mitigation, emergency preparedness became, in the context of modernity, an arena where policy and scientific expertise are deeply intertwined. This specific parameter of risk management involves a large array of activities directed to threat identification, advanced planning disaster response and post-disaster recovery.

As Mileti (1999) rightly posits, in an ideal world self-reliant systems and human agents, e.i individuals, groups, organizations, governments or communities, would accurately assess risks and take adequate steps to avoid, mitigate, respond and recover from disaster on a sustainable way. But, in the real world, risks tend to be systematically underestimated and adaptive processes towards extremes are critical. Constraints usually interpose on the way and are presently well identified and documented.

As mentioned above, centrality given to risk issue and the way it is (or not) dealt is largely dependent on systems and human agents' experience of risk. Social construction of environmental

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[5] There is presently a relevant amount of research uncovering the paradoxes of strategies solely based on structural hazard control methods. Indeed, such methods make land exposed to natural hazards more safe for human occupancy and profit, but have the inconvenience of generating the illusion of complete safety and threat elimination, which becomes on a strong stimulus for development (Silva, 2001). As a consequence of this, hazardous areas tend to grow exponentially and increase their vulnerability towards low-probability risks. According to Burby (2006) analysis of hurricane Katrina, the huge impact of this extreme event as on its basis what he calls as safe development paradox. Levees and coastal protection works, made along decades, had the intended effect of easing development on hazardous areas and the unintended effect of contributing directly to the devastation of Hurricane Katrina.

hazards as being exogenous to social systems favours fatalistic attitudes or, in scenarios of pro-activity, generates strong belief on technology as the main and sole way of restraining the "forces of nature". Societal investment on anticipatory processes of risk reduction implies, as mentioned above, the previous social recognition of hazards as endogenous to man-environment relations.

Adaptability processes towards environmental extremes, namely the ones stood on *rule regimes* directed to regulate human action physically inscribed, imply the involvement of a multiplicity of human agents, i.e. individuals and households, business and private organizations, expertise groups and hazard professionals, governments and government agencies. Each of these stakeholders has their own representation of risk and differs in terms of awareness, knowledge about risks and protective actions, capability to implement adaptive behaviours and pre-disposition to act in conformity with the rules (Lindell, 1997). Besides, each of these stakeholders bring to social arena their own interests and have their own agendas, which means that there are more goals at stake (and in conflict) than the ones specifically related with the investment on adaptive processes conducing to a resilience upgrade towards environmental extremes. Furthermore, one should not disregard power issues. Stakeholders have differential levels of power to either induce other stakeholders to accept their views or to resist to others' influence attempts.

Among the diversity of stakeholders above identified, two of them are fundamental to the surpassing of risk awareness stage to policy adoption stage. We refer, on the one hand, to political and governmental stakeholders with institutional power to create or change rule systems, to allocate resources and influence action in conformity with the rules, and, on the other hand, to expert stakeholders, due to their scientific authority. Apart from circumstantial situations[6] and their institutional positions, the unchaining of any process of policy adoption, is rather dependent on these stakeholders agential power (Burns, 2007a), their entrepreneurship, their skills, values and interests. Above all, both groups dynamics and communication must lead to, or be pursued on the basis of, a shared cognitive and operative knowledge. This is something difficult to achieve. Environmental hazards and disasters is an arena where typically lacks political urgency. It is difficult to convince political actors and key decision-makers to devote time and attention to low-probability and uncertain problems when their agenda is full of other competing, short-run and acknowledged problems (Berke et al, 1992). Experts can exert an important role and several studies (Berke et al, in

[6] Directed or indirect experience of disaster is among the most circumstantial situations which can turn on "windows of opportunity" (Tierney, 2001, Mileti, 2003, Berke et al. 1992) for change and unchain processes of resilience increase.

ibid; Stallings, 1995; Alesh et al, 1986) have demonstrated the importance of these stakeholders on policy processes. Their expertise is an important resource and, besides, they can play the role of advocates, trying to increase social salience towards risk' issues. Their advocacy may lead, on the long run, to the surpassing of political barriers or not.

Indeed, the presence of expertise is a fundamental resource in any process of risk reduction and management and its unavailability can function as a barrier to the unchaining of adaptability processes. Moreover, scarcity of economic resources can also become an important impediment. Fragile scenarios from the economic point of view tend to be more prone to environmental degradation and susceptibility towards hazards. Such fragility is either materialized in the form of social vulnerability towards hazards — which usually follows the structure of social inequalities — and through the lack of assets necessary to invert such cycle.

Apart from obliging to a behaviour change, risk reduction policies, more specifically the ones that imply a different relation with land, imply to make concessions and involve costs. The value of public safety and resilience collides with values of land as a commodity and involves public and private costs. This makes risk mitigation policy adoption a conflictual process where different interests enter on confrontation. Policy promoters and advocates will use their power and influence to enforce rules changing whereas other stakeholders, i.e. real state developers, business stakeholders, property owners and residents will use their agential power to resist to the rules, re-adapt them according to their own interests or even ignore them. The result of such conflictual processes will depend of the extent to which convergence is achieved. But the sole anticipation of conflict can be in itself a barrier. Policy-makers may fear the political costs of going against their constituencies and loose the immediate benefits of favouring urban development strategies. Indeed, while the benefits of an investment on adaptive capability towards environmental hazards are not immediately evident — due to the irregular nature and often low-probability of risks — social and economic costs are quite immediate. Concerning these, the main challenge is to arrive to a fair balance between private and public costs of resilience up-grading. The feeling of unfairness on the part of stakeholders that see themselves as losers of the policy may become a barrier to policy implementation.

The nature potentially conflictual of risk reduction suggests the inadequacy of traditional "government" forms of regulation and advices to innovate, namely on the direction of governance forms. Burns defines governance as complex social steering processes where competencies are

shared among multiple actors and where decision-making is worked out with the participation of all interested parties, i.e. political agents, economic influentials and representatives of communities. This type of strategy seems to be more appropriate to the arrival of a *shared cognitive and operative knowledge* between stakeholders, a basic condition for the surpassing of conflict.

4. Concluding remarks

The purpose of this paper was to establish the main foundations of a theoretical framework to approach risk, human patterns of coping with it and factors underlying its variability. It is, thus, an unfinished exercise. Nevertheless, it set the basic principles and discusses some of the core concepts. Actor-System-Dynamics theory of Burns (2006; 2007a), Burns et al (2007b), and Burns & Flam Social Rule System theory (2000) appeared to us as a fundamental theoretical basis for the reflection pursued. Yet, some aspects of these theories remained unexplored and further exercises of going deeper on our reflection will require re-visiting them again. For now, we will close this paper with a synthesis of the main postulates underlying the basis of our theoretical framework.

This paper starts with a refusal on envisaging risk, and its expression in the form of a disaster, as something exogenous to social structures and human agency, more specifically as far as it concerns to their relation with environment. The understanding of risk, its causation and magnitude, should stand on the analysis of the interplay between social structures, human agency and environment, in time and space.

According to Burns et al (op cit), human activity is regulated and organized by socially produced rule systems. These are important mediators of the relationship between social structure and agency. In our view, by mediating the relationship between these two poles, social rule systems also mediate the relationship between them and the environment.

Social systems and human agents' interactions with their environments renders concrete through adaptive processes. In the context of modernity, technology, jointly with rules and rule systems, is both the vehicle and product of adaptive processes. These may, in turn, take different courses. They increase adaptive capability towards environment or, on the contrary, to create new constrains, exacerbate vulnerabilities or create breakpoints on resilience towards eco-systems.

For long, risk was conceptualized by only taking into account its physical dimension and neglecting socially produced facets. Indeed, risk has inherent real and objective, materialized in the possibility of occurrence of environment-related events that can induce on some kind of disturbance to social systems and human agents. But, eco-systems don't speak by themselves and the identification of certain phenomena as a source of hazard its social construction as a risk. Besides, social systems and human agents interfere on environmental processes. Consequently, they cannot be set outside risk causation and magnitude processes. Their patterns of interaction with eco-systems may exacerbate vulnerability towards hazards or, on the contrary, induce on an increase of adaptive capability and resilience.

In general terms, adaptive capability is a function of the degree of societal investment on risk mitigation processes as well as on emergency preparedness. The extension of such investment is, in turn, extremely variable. Factors interfering on such variability can be of several nature. Roughly speaking, we would say they range from the social experience of risk to the human capability on implementing informed policy processes.

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