What do we really know about emerging risks? A literature review and some comments.

Chabane MAZRI
Institut National de l'Environnement Industriel et des Risque INERIS.
Parc Technologique ALATA, BP2

60550 Verneuil en Halatte, France.

ABSTRACT: The issue of emerging risks is today recognized as an important concern for risk governance. Several organisations have developed their own definitions of this concept and deduced from that a framework to deal with them. This paper aims to compare the various definitions associated today with this term and tries to infer a conceptualization of the concept of emergence in risk management. Through a detailed analysis, we will see that the heterogeneity of existing definitions and their inability to clearly distinguish the concept of emerging risks from other existing risk typologies require to explore more in depth the concept of emergence and its implications for risk management.

1 INTRODUCTION

The issue of emerging risks knows an increasing interest amongst both public and private decision makers (OECD, 2003) (OSHA, 2005) (ENISA, 2010) (IRGC, 2011). The subprimes crisis in 2007, social unrests in Arab countries, or SARS epidemic are a few examples of how some systems' dynamics have dramatically challenged our previsions and understanding of their mechanisms and evolutions.

It also strongly shacked the foundations of our risk governance approaches that seem to be more adapted to routine based risks than to fast evolving, highly uncertain and multi stakeholders' ones. Furthermore, those risks seem to ignore all boundaries usually determined by governance structures and scientific disciplines (IRGC, 2010). The financial crisis has for example raised several issues at the whole European level that revealed all the economic and social discrepancies amongst EU countries' policies; the global warming and its potential consequences raise several economic, social and technical issues that require holistic approaches instead of disciplines based visions. On the other hand, the stakes at play are huge: possible collapse of whole systems as it was the case for financial institutions, dramatic limitations in access to water or ocean acidification in the case of global warming, worldwide epidemics in case of virus mutations…

In this context, what strikes at the very first sight is the great variety of risks that may be comprised under the umbrella of *emerging risks*. What are the common properties that are shared amongst them? Do those common properties allow a unified and still sophisticated approach? In other words, to which extent should those risks share a common definition and how such a definition may lead to develop adapted answers?

This paper will review 9 emerging risks definitions used by international organisations in several domains: occupational health and safety, food safety, insurance... Our aim is to question the homogeneity of the way emerging risks are treated by those high level organizations in order to identify common patterns that may be shared with smaller organizations. Our claim here is that emerging risks are not prerogatives of international organizations; they are also challenges to be dealt with at companies' levels, even the small ones like SMEs.

2 LITTERATURE REVIEW

As Beck (1992) stated it, our modern societies put risks repartition at the very center of the societal debate, especially regarding the questions raised by fast evolving technologies that continuously challenge the equilibriums we try to define. In this context, the idea of new risks that emerge as a consequence of various dynamics (economic, technological, demographic…) raise central questions as the issue of their repartition and management is to be correctly dealt with as early as possible.

According to the above, more and more international organizations have adopted definitions (see table 1 below) that describe the way they deal with the idea of emerging risks in their policies.

Table 1 Panorama of emerging risks definitions.

Authors	Definition
1. European Agency on Health and Safety at Work (2005).	New and emerging risks are any occupational risk that is both new and increasing. By new, we mean that: • the risk did not previously exist and is caused by new processes, new technologies, new types of workplace, or social or organisational change; or, • a long-standing issue is newly considered as a risk due to a change in social or public perceptions; or, • New scientific knowledge allows a long-standing issue to be identified as a risk. The risk is increasing if: • number of hazards leading to the risk is growing; or • the exposure to the hazard leading to the risk is increasing (exposure level and/or the number of people exposed); or • The effect of the hazard on workers' health is getting worse (seriousness of health effects and/or the number of people affected).
2. European Food and Safety Agency EFSA (2007)	A risk resulting from a newly identified hazard to which a significant exposure may occur or from an unexpected new or increased significant exposure and/or susceptibility to a known hazard.
3. Swiss Re (Russell, 2007)	Developing or changing risks which are difficult to quantify and may have a major impact on insurers' book of business.
4. International Risk Governance Council IRGC (2010)	Risk that is new or a familiar risk that becomes apparent in new or unfamiliar conditions.
5. European Network and Information Security Agency ENISA (2010).	Risks that may have an impact between one and five years in the future, while the future risks…may have an impact in more than five years…
6. Price Waterhouse Coopers (2009)	Those large scale events or circumstances beyond one's direct capacity to control, that impact in ways difficult to imagine today. Emerging risks cover unknown costs of known events/risks, and unknown costs of unknown risks.
7. The prudential Insurance company of America (Barney, 2011).	A condition, situation or trend that could significantly impact the Company's financial strength, competitive position or reputation within the next 5 years.
8. Lloyds (2007)	An issue that is perceived to be potentially significant but which may not be fully understood or allowed for in insurance terms and conditions, pricing, reserving or capital setting.
9. National Academy of science (2012)	Refers to the likelihood that a new material will cause harm in ways that are not apparent, assessable, or manageable with current risk-assessment and risk-management approaches.

The long list of distinct definitions detailed above reveals the heterogeneity of significations and understandings various organisms associate to the concept of emerging risks. If such a heterogeneity can be explained, to a certain extent, by the variety of domains and applications associated to those sources (Food safety, insurance industry, consulting companies, international organisms…), we will see below that it is also the result of real discrepancies in the very conceptualization of the term "*emerging*". In order to be exhaustive and concise, we tried to extract those various conceptualizations and describe them through what we called **descriptive factors**. Those factors are meant to capture what we believe as an important property one or several definitions associate to the concept of emerging risks. In the followings, each of those descriptive factors is analyzed according to its capacity to characterize and differentiate emerging risks from other types of risks already described by former typologies (Renn & Klinke, 2002) (Renn, 2006) (OECD, 2003). We are trying here to answer two distinct questions: How are emerging risks different from other types of risks? If yes, what could be, according to those definitions, the shared properties of a specific category of risks called "*emerging*"?

Descriptive factor 1: Temporality of occurrence

Definitions 5 and 7 relate the emerging character of a risk with its expected temporality of occurrence. In other words, emerging risks are existing or forthcoming risks which consequences may occur within the next five years. Temporality is here used as a segregating parameter allowing organizations to set priorities; emerging risks having the priority comparatively to longer term risks. Barney (2011) specifies that such a definition should orient organisations towards a forward looking and an early definition of mitigation opportunities. By insisting on the need to look forward and anticipate future evolutions, one can implicitly infer from this definition that emerging risks are evolving risks that need to be understood according to their dynamics and not only regarding their past behavior. The dynamic character of risks is also explicitly treated by the descriptive factor below.

Descriptive factor 2: Dynamic character of the risk

Definitions 1, 2, 3 and 4 consecrate the dynamic character as the main property of an emerging risk. Emergence is here described as the result of one or several dynamics that may change the nature, probability, intensity or vulnerability associated to some risks. Various types of dynamics may lead to create/ reveal new risks or change existing ones:

- *Scientific dynamic*: If a new knowledge puts into light new pieces of evidence that a risk exists. For example, new evidence that specific electromagnetic fields may increase likelihood of cancers will naturally change both expert risk assessments and social perceptions related to this technology.
- *Technological dynamic*: If new products or processes generate opportunities that may lead to new or change existing ratios of costs and benefits regarding exposure to risks. For example, nanotechnologies create new opportunities of innovative health treatments (Lloyds, 2007) and reduction of energy consumption (NAS, 2012) as well as important health and environmental threats (Maynard et al, 2007) (NAS, 2012). Those opportunities and threats create new configurations of costs and benefits within which new or existing risks need to be (re)studied.
- *Social and psychological dynamics*: If new behaviors generate new forms of exposure or increases already known patterns of exposure. New or evolving perceptions can also create social dynamics that may change the perceived level of risk (IRGC, 2010). The most recent example is the evolution of nuclear risk perceptions after Fukushima accident, and more generally, after each nuclear accident (IRSN, 2012) (Prati & Zani, 2012).

Descriptive factor 3: Uncertainties

Definitions 8, and 9 highlight uncertainties, and sometimes the ignorance, associated with the probability and/or magnitude of consequences an emerging risk may generate. More precisely, those definitions refer to the unavailability of past data when assessing those consequences as well as the limited character of our detection devices or techniques. According to those definitions, emerging risks are existing risks for which an important uncertainty still exists making the management and regulation arrangements always subject to potential re calibration in case of new pieces of scientific evidence or social evolutions in risk perception.

Descriptive factor 4: Magnitude of consequences

Definitions 2, 3 and 6 characterize emerging risks through the potential large magnitude of consequences that may go beyond the limits and management scope of a unique organisation. The notion of uncertainty is here also present as well as the possibility that consequences may threaten a whole set of organisations that present the same vulnerabilities to the emerging threat. Such definitions are thus very close to the notion of systemic risks defined by the OECD (2003) as *risks that affect the systems on which society depends-Health, transport, environment, telecommunications*, etc. Emerging risks are here characterized regarding their ability to widespread in a very uncommon way (IRGC, 2011) that may impact not only one stakeholder but systems at a whole regarding their similarities or interconnections (IRGC, 2011).

3 ANALYSIS

A fast lecture of the various factors inferred from the set of definitions described in table.1 reflects the heterogeneity of the understandings lying behind the concept of emerging risks. Depending on what one chooses to consider as a distinctive property, management of emerging risks may be oriented in various directions: development of knowledge to cope with uncertainties, reduction of systems interconnections to cope with magnitude of consequences…

Our objective here is not to favor one definition over another; it is more to highlight how this term triggers today various understandings which, consequently, may generate ambiguities.

In addition to that, we believe it important to analyze also those factors according to their ability, alone or all together, to provide a sufficient basis to characterize a specific category of risks to be called "*emerging*". In other words, how do emerging risks distinguish from other types of risks already defined by existing typologies?

This second point is of importance. If emerging risks are really to be distinguished from other categories, this means that risk managers will need to develop dedicated management frameworks or enlarge existing ones to fit with new requirements. If not, this means that existing frameworks could be satisfactory and no further developments required.

Regarding descriptive factors 1 and 2, it seems natural to adopt the novelty and/or the evolving characters as distinctive properties of emerging risks. However, according to a managerial perspective, the novelty or the evolving characters of a risk can hardly be stated proactively, especially in case of risks which future behaviors are uncorrelated from past ones. Therefore, the deployment of a dedicated framework for emerging risks management cannot be performed before the irreversible observation that a new risk has emerged or that an existing risk has changed in a significant and unpredicted manner. Of course, actions still can be taken before the occurrence of the risk. However, we need to acknowledge that such actions might be taken in a context where other stakeholders, including the public, are aware of the existence of this risk and of the lack of a structured and coherent policy to deal with it. Therefore, we believe that adopting those properties to characterize emerging risks will more likely place decision-makers, and the society in general, in reactive postures instead of proactive ones; which is an important drawback when it comes to risk management policies. Consequently, we believe those properties as more adapted to define already emerged risks that still require specific management approaches (Rossell, 2007) (IRGC, 2011) (Jovanovic et al, 2013) instead of risks in the process of emergence.

Regarding uncertainties (descriptive factor 3), We believe it difficult to consider the presence of uncertainties in risk assessment as a sufficient or systematic condition to consider a risk as emerging. Regardless of the various sources of uncertainties that may be generated either by a lack of knowledge or by the system's variability (Van Asselt & al, 2001), It is widely acknowledged that risk assessment and management in general may comprise high uncertainties (Renn & Klinke,2003) (Renn, 2006) even for what are considered as familiar risks. Renn and Klinke (2003) have acknowledged this statement by suggesting a risk typology where risks characterized with high level of uncertainties are distinguished as *uncertainty induced* risks.

The Buncefield accident (2005) is a good illustration of such a situation. It occurred in an oil storage facility near Heartfordshire, England. Uncontrolled filling operations lead to oil overflowing from tank 912. A rich fuel/air mixture rapidly expanded and an ignition source lead to a

massive explosion as a result of a physical phenomenon called Unconfined Vapor Cloud Explosion (UVCE). If UVCE in storage tanks is a widely known risk for several years, experts were surprised by the intensity of the explosion that did not match with analytical models and simulations widely shared in petroleum community (Buston et al, 2010). Furthermore, several UVCE already occurred in the past: Texas city (USA) in 2005, St Herblain (France) in 1991, Ufa (Russia) in 1989, Napoli (Italy) in 1985 allowing experts to calibrate their models according to past experiences. This example suggests that what can be considered as familiar risks can also comprise uncertainties that, when revealed through either scientific advances or because of an accident, may totally change our understanding of its probability or magnitude of consequences. Accordingly, it appears to us that uncertainty cannot be considered as a distinctive property to create a new category of risks called emerging. Otherwise, almost all existing and supposed well known risks are to be considered as candidates to this new category. However, this does not mean that emerging risks do not comprise uncertainties; we only admit that uncertainties are not a sufficient condition to label a risk as emerging.

Regarding descriptive factor 4 (magnitude of consequences), risks generating consequences which magnitude goes beyond the limits of one organization are already experienced at several stages in our societies by various stakeholders. A first example that still challenges our societies' organizational capacities is crisis management in case of an industrial accident. Thousands of dangerous plants around the world generate risk scenarios which consequences may go far beyond the plants' limits requiring the intervention of public forces according to local regulations (EC 96/82 directive, 1996), COMAH regulation in UK (1999)… The technical and organizational issues raised in such contexts are widely studied in the scientific community (Penning et al, 2006) (Coria, 2011) (Vascoukis et al, 2012) and still require further developments. At higher levels, the notion of systemic risks have been widely discussed (OECD, 2003) those last years, especially after the subprime crisis in 2007 that threatened the whole financial system. The issue of defining systemic risks as threats caused by unpredictable, highly improbable, exogenous stochastic events (Albeverio et al, 2006) or as results of endogenous structural weaknesses (Golding and Vogel, 2010) goes beyond the purpose of this paper. We will simply acknowledge the fact that systemic risks have the ability to threaten large systems on which our civilization relies (OECD, 2003) in several sectors: Contagion of dangerous financial products in banking systems, global collapse of multi-stakeholders electric grids , global failure of electronic systems in case of intense solar storms, global warming…

According to this definition, we consider that risks impacting large systems, requiring multiple stakeholders' collaboration and resulting from complex interactions are already considered in existing risk typologies through the concept of systemic risks. Therefore, magnitude of consequences can hardly be considered as a determinant of emergence when dealing with risks. Once again, this does not mean that a systemic risk cannot be considered as emerging. Nevertheless, we contest the magnitude of consequences as a unique neither a sufficient condition to define a risk as emerging.

4 CONCLUSIONS

No property or combination of properties suggested by the various definitions in table.1 allow a complete differentiation of the concept of emerging risks comparatively to other risk types usually found in literature. Consequently, we believe the questions rose at the beginning of this analysis, i.e. the existence of a real distinction between emerging risks and other risks and the list of properties founding this distinction, are still unanswered at this level.

However, this does not mean that we deny the existence of emerging risks. We will rather plead for a better definition and characterization of this concept through a thorough analysis of the concepts of emergence as defined in the dense literature related to complexity science.

The stakes behind the construction of such a definition are high:

- Avoid ambiguities related to several definitions lying behind a single concept.
- Better distinguish emerging risks comparatively to existing risk types and thus better identify specific needs in terms of management frameworks.
- Provide everyday risk managers in smaller organizations with clear and transposable definitions and methodologies for emerging risks screening and mitigation strategies.

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