Chapter 4
Learning from Past Disasters to Prepare for the Future

Julien Rebotier, Patrick Pigeon, and Michael H. Glantz

Abstract This chapter revisits a well-known paradox in disaster studies: why does humankind suffer more losses while knowing more and in spite of innumerable existing disaster risk reduction policies? This paradox questions the ability of societies to learn from disasters, which is the issue that this chapter investigates. The first part presents the gap existing between a logical requirement to learn from the past while trying to mitigate if not prevent disasters. The gap – between possessing more knowledge in the face of mounting losses – still exists in spite of the capacities to reconsider DRR policies and to promote new tools helping decision-making processes, as with knowledge management systems (KMSs). Such shortcomings in addition to certain aspects of human nature, such as a government's very short interest and attention span in any given crisis, seek to identify factors explaining why capacity to learn is limited today. The second part of this chapter draws attention to why, as well as how, to take into account local settings and local knowledge when framing risk-reducing policies. The latter are still highly compartmentalized for a variety of challenging reasons. However, opportunities and challenges demand immediate consideration. Societies must bridge, blend or mainstream their policy concerns about planning for future climate change adaptation (CCA) with attempts at policy development for disaster risk reduction (DRR) today, especially because hydrological and meteorological extremes that were expected by 2050 are beginning to confront societies now.

Keywords Capacity to learn · Disaster prevention policies · Climate change adaptation · Disaster databases · Contextualization · Disaster preparation

J. Rebotier
French National Centre for Scientific Research, LISST Laboratory – UMR 5193, Maison de la Recherche, Toulouse, France

P. Pigeon (✉)
Pr University Savoie-Mont-Blanc
laboratoire "MÉDIATIONS – Sciences des lieux, sciences des liens"
Unité de Recherche de Sorbonne Université, Le Bourget-Du-Lac, France
e-mail: patrick.pigeon@univ-smb.fr

M. H. Glantz
CCB (Consortium for Capacity Building), INSTAAR/University of Colorado, Boulder, CO, USA

S. Eslamian, F. Eslamian (eds.), *Handbook of Disaster Risk Reduction for Resilience*, https://doi.org/10.1007/978-3-030-61278-8_4

1 Introduction

Those Who Fail to Learn From The Past Are Doomed To Repeat It. –George Santana

One of the biggest challenges concerning disaster risk reduction (DRR) policies, which aim at reducing losses, is to understand why they still meet numerous obstacles, when it comes to implementation or enforcement. This issue has been stressed numerous times for ethical as well as economic reasons and is considered key by international institutions such as the United Nations Office for Disaster Risk Reduction (UNDRR) or the World Bank. First (Sects. 2, 3, and 4), in spite of obvious logical and ethical requirements, databases on disaster clearly prove the capacity to learn but also expose numerous limitations. Reconsidering existing DRR policies and using new tools as with knowledge management systems (KMSs), which help decision-making, do not change the global assessment in any major way. Then (Sects. 5, 6, and 7) epistemological and institutional reasons explain why information and knowledge about losses are still very fragmented today. Contextualizing and territorializing disaster prevention to a greater extent should help to reduce the gap between what is expected from DRR policies and what statistics show. In spite of the numerous biases they have and the study limitation, there are pitfalls and opportunities of a deeper integration between DRR and climate change adaptation (CCA) policies.

2 Learning from the Past Disasters Should Be a Logical Requirement, Despite Notable Limitation

2.1 Learning from Past Disaster: A Logical Requirement Difficult to Represent

To learn from the past supposes integrating the build-up of knowledge of past events as a basis for decision-making processes about building back better following the occurrence of a new disaster (Weichselgartner and Pigeon 2015). As such, lessons identified (often referred to as lessons learned) are usually taken for granted as a key consideration for DRR in terms of awareness-raising, understanding and managing. Indeed, when it comes to prevent a disaster, it makes sense and seems logical to reconsider the situation existing before the event. In line with the so-called radical view about the societal and environmental risks (García-Acosta 2005; Wisner et al. 2004), damages depend first of all on how human societies of concern were structured long before the foreseeable hazard occurs. Various types of political decisions contribute to frame risk-prone situations in the long term, especially when the question arises about where and how to build structures. Disaster prevention and preparedness are, therefore, related to a wide array of decisions which take into

consideration the functioning of societies on a day-to-day basis. This is often perceived to be the normal period, which fortunately is the prevalent situation.

This understanding strongly reduces the role hazards might play to explain the extent of damages experienced, which also determines what a disaster is. EM-DAT, the well-known database which is managed by CRED (2019), defined a disaster as an event exceeding the threshold of 10 people dead and/or 100 people affected and/or needing external help. Consequently, when it comes to disaster prevention after the occurrence of an event, it makes sense to reconsider the structure of societies existing before the disaster and to reconsider the related political choices. Therefore, learning from the past should be a first logical requirement to prevent a disaster.

Moreover, the widely used disaster cycle model, depicted as a "pragmatic concept" and has existed since 1975 (UNISDR 2015: 30–31), integrates learning from the past into the reconstruction process as a major obvious contribution to disaster prevention. The representation of a cycle seems to be consistent with the logical need to reconsider the existing socio-economic and political situation, which the disaster's occurrence exposed as problematic when the hazard occurred.

However, the cycle implies that following a disaster it might be possible to return to similar conditions that existed before its occurrence. In light of the so-called radical view mentioned above, the cycle representation becomes illogical. A solution would be to use spirals (Morin 2005; Michellier et al. 2020). They propose the idea of a cycle, while clearly depicting the difficulties to turn back to a previous situation once the disaster ended, especially when it comes to disaster prevention. However, spirals are harder to present and to read.

The general understanding of disaster prevention looks very ambiguous and balanced. A similar message arises from disaster databases. They indicate at the same time prevention shortcomings (Sect. 2.2) and achievements (Sect. 2.3).

2.2 Disaster Prevention Limitations and Increased Losses: Not Learning Enough, or Correctly, from the Past?

In spite of the obviousness of integrating learning from past disaster prevention policies, academics as well as managers admit that they collect, absorb or apply lessons identified and/or lesson learned (often represented as recommendations or findings) much less than is expected by the public, by researchers or by international institutions devoted to risk prevention. Evidence of such shortcomings is numerous. Disaster databases address first the limitations that confront disaster prevention policies. An analysis of disaster databases proves that "experience return" is less directly taken into consideration by disaster prevention policies than one might reasonably expect. Assessing the results, disaster prevention policies deliver more balanced outcomes. A closer reading of those databases reveals the contribution of disaster prevention policies toward reducing damages, as might be expected. Such assessments should include the ambiguous contributions that past experiences play,

when it comes to prevent disasters. The assessments reveal that there is no direct relationship between information or knowledge about past events and disaster prevention policies. A similar mismatch exists between disaster prevention and preparedness policies and their implementation. Some disaster prevention policies try to integrate both aspects, while explicitly addressing "experience return" about the limitations encountered by previous disaster prevention policies. This process is very close to the principle of reflexivity that Beck (2001: 16) promoted. It justifies the rise of new tools to help decision-making processes and inspire the evolution of disaster prevention and preparedness policies, as well as new knowledge types, as is the case with KMSs.

The most striking evidence of limitations to learn from the past is exposed by statistical trends concerning disasters. This paradox has been stressed by the famous observation by American geographer Gilbert White (White et al. 2001): "The more we know, the more we manage, and yet the more we lose". This concern has also been investigated now and again during such international, multidisciplinary gatherings as, for example, the one that took place in Antalya, Turkey, a few years ago on "Lessons Learned About Lessons Learned" (Glantz 2015). The same paradox appears in the trends identified in disaster databases such as displayed in EM-DAT (Emergency Database, CRED 2019).

In spite of the various methodological limitations of those databases, the upward trend for disasters is clearly exponential on a centennial timescale. This trend is not related on a specific database, which would reflect methodological choices only. It is also displayed by databases such as DesInventar (D'Ercole et al. 2009; Pigeon and Rebotier 2016). Even more, the 2015 Global Assessment Report (GAR) stressed the relevance of taking into account events not identified by databases at the world scale, such as EM-DAT. Those "small" or "extensive" disasters (UNISDR 2015) are identified at local scales, as is the case in Medellin, Colombia (López-Peláez and Pigeon 2011). Their identification by databases such as DesInventar helped us to understand how local disasters are "set up" by urbanization dynamics. One of the main goals of DesInventar is to list and to map those disasters, helping local managers and households to prevent them in the future. Numerous studies investigated the limitations of using similar databases (Menoni and Margottini 2011; Mitchell et al. 2014), yet the general trend is always the same: an increase of disaster frequencies, in spite of existing prevention and preparedness policies and in spite of the call to integrate "experience return" into decision-making to a greater extent.

However, a closer and more critical reading of databases draws attention on the relevance of learning from the past to disaster prevention.

2.3 *In Spite of Increased Losses, Disaster Statistics Also Show the Relevance of Learning from the Past*

When delving into the details of statistics related to disasters, a striking difference between human losses and economic losses is found. Human loss trends show a much lower increase than economic losses and, in some cases, even a decrease. In both cases, trend assessments stress the various difficulties researchers meet when working on economic losses or even on mortality. According to Mitchell et al. (2014), "it is not possible to establish a true statistical average for mortality or economic losses from only a few decades of national data". This shortcoming results from a limited time series but also from the poor quality of the data and information concerning losses. A unified methodology does not exist, even in case of the relevance of framing one for major stakeholders, as exemplified by data on losses that states or insurance companies collect (André 2013; Cazaux et al. 2019). However, at least as concerns mortality related with floods, numerous studies discussing a decreasing trend are found, for example, in Southern France (Boissier 2013), in Portugal (Pereira et al. 2015) or in Spain (Olcina et al. 2016). Such results may reflect limitations due to short time series, to difficulties linking mortality to a specific hazard or to methodological choices related to definitions, among others. However, those results deliver several orders of value, proving that learning from the past and integrating such knowledge in disaster prevention policies likely contribute to reduce losses.

In the face of existing trend toward more people living in flood-prone areas, which is one of the major findings of the previously mentioned research, it is not possible to explain declining mortality trends without integrating the contribution coming from policies of prevention. The understanding of the situation cannot reflect a European exception or cannot arise from a specific hazard-type only. Analysis of the 2010 disaster related to the eruption of Merapi volcano in Indonesia exhibits similar results (Picquout 2013). For example, 350 people were reported dead during the various phases of the volcanic eruption, compared to the evacuation of more than 1 million people from the exposed area. What would have been the casualties in the absence of prevention policies and the use of existing information and knowledge about previous disasters? For the Merapi volcano, no less than nine eruptions occurred since 1872, with information also available on casualties and displaced people. In spite of numerous limitations – related to a wide range of uncertainties about the geodynamics of the eruption or about the timing and conditions of the evacuation of people from the exposed slopes of the volcano – learning from the past contributed to preventing a major disaster. Existing information was transformed into usable knowledge to justify risk maps and evacuation plans, in spite of limitations.

Thus, disaster databases simultaneously embed obvious limitations of disaster prevention policies as well as their hidden capacity to prevent. Such an ambiguous statement mirrors both the limitations and relevance of learning from the past.

3 Learning from the Past Explains the Evolution of DRR Policies and Tools

3.1 Reconsidering Existing Disaster Prevention Policies

As the integration of information into knowledge concerning past disasters in disaster prevention policies is found relevant and limited, it makes sense to reconsider how those policies were framed and to what extent they integrated "experience return". This issue does not only concern risk prevention but also a wide array of policies on land-use management.

During the last decades, numerous European-funded research programmes tried to investigate relationships between land-use management and disaster prevention such as ARMONIA (Menoni and Margottini 2011) and CapHaz-Net (Kuhlicke and Steinfuhrer 2010). They attempted to identify the means (1) to integrate both aspects, disaster prevention and land-use management, and (2) to bridge the gap between hazard-centred research on risk and research coming from the social sciences.

To illustrate those links, policies dedicated to what the French state named dike risk are presented. The issue of dike risk was identified many decades ago by American engineers and by Gilbert White (Macdonald et al. 2012). They found that dikes, as other protective and corrective works, tend to procure a delusive sense of security. They called it the "levee effect". The latter may induce local stakeholders to consider that dikes could be a means to eradicate flood risk. Consequently, it could be possible to build on flood-prone areas, without taking under consideration this type of risk. Indeed, dikes contribute to reduce flood frequencies. However, dikes, as corrective works, transform the physical parameters of rivers as well. In some cases, those transformations escape human control and contribute to increase river erosion, therefore, limiting the protection the dikes were meant to provide. Meanwhile, numerous "experience returns" proved that dikes contribute to reduce flood frequencies but do not allow the so-called protected areas to cope with flood events with higher energy and lower frequency of occurrence. Basically, human-built dikes, as elements of wider hydro-systems, unwittingly tend to produce conditions that create their own limitations. The latter trend has been specifically demonstrated in mountainous areas, where diking tends to increase mountainous river-specific power and also their destructive potential (Pigeon 2017).

Consequently, not taking dikes limitations into account while building on areas that are technically still flood-prone sets off preconditions for an eventual disaster. Taking stock of such disasters that happened during the previous decades (Le Grand-Bornand 1987; Vaison-La-Romaine 1992; Aramon 2002; La Faute-sur-Mer 2010), the French state decided to promote the integration of a specific zoning into a land-use tool dedicated to disaster prevention: the risk prevention plan (RPP). The new zoning type has been named dike risk which recognized at the very same time the relevance of diking, as dikes contribute to reduce flood frequencies, and the limitations that those corrective works meet. The zoning justifies forbearing

buildings on areas where dikes increase flood risks, with the *RPP red zone* dike risk, and to adapt buildings in case of local decisions to still use flood-prone areas, with *RPP blue zones*. The French state local representatives use information on past floods and on dikes limitations to defend this solution. Indeed, the latter looks strange, as it reconsiders the traditional role dikes play: they are still currently presented as a protective work.

Basically, the evolution fits larger trends, which reconsider structural measures in the face of sustainable development principles, and also aims at "implementing room for the river" or "more space to the rivers" (Pigeon 2013). The latter expressions have been promoted by academic studies coming from the Netherlands (Warner and Van Buuren 2011).

In spite of such justifications, the implementation of those prevention policies integrating dike risk zonings still meets considerable opposition coming from various stakeholders, mainly local. They challenge the relevance of the structuring of information on "experience return", this time not only about previous disasters but also about previous existing disaster prevention policies, into a new form of knowledge suggesting to strongly reduce building initiatives. Those limitations, in turn, call for the development of new tools, hoping to increasingly strengthen the position the French state defends, in line with other main stakeholder implied, as is the case here with insurance companies. The evolution is dialectic and fits the understanding of policies that Beck (2001) and also Revault D'Allonnes (1999), among others, promoted.

3.2 *Knowledge Management Systems (KMSs): Tools that Help to Learn More from the Past*

A KMS integrates several existing databases, favouring information sharing and, therefore, the creation of knowledge (Weichselgartner and Pigeon 2015: 109). Basically, it can be understood as a tool helping to manage "experience return" and to structure information which is highly segmented and heterogeneous. This tool should help us to learn more from the past. In particular, KMSs try to compensate for the increasing segmentation (compartmentalization) amid multiple institutions and stakeholders that are imbedded in disaster prevention and which provide information. As such, the tool is not new: similar experiments were tried during the 1970s and applied at least in North America, in order to help find solutions to environment-related conflicts. KMSs are consistent with the understanding of disasters that the resilience alliance group seeks to promote (Berkes and Folke 2002). A KMS defends the relevance of systemic and socioecological approaches when addressing issues related to disaster prevention and tries to provide a more applied aspect to this type of very abstract thinking.

Since 2012, one of these KMSs, the "National Observatory of Natural Hazards" (ONRN), has been developed. Managed by the "mission des risques naturels", it

incorporates several major databases that were previously separated. In particular, it integrates databases concerning damages recorded by insurance companies in France. The ONRN helps to display the results and limitations related to the implementation of the French major disaster prevention policy, launched in 1982. The scale of assessment is not only national but also local. The French municipality, as a local data cell, allows one to cross-check data on the number of disasters officially recognized by the French government since 1982, existing risk prevention plans, and claims data from insurance companies (Nussbaum and Pigeon 2015). The ONRN thus provides a stronger, shared database helping to assess elements that contribute to disaster prevention and management. This KMS also can be used to assess how the situation is for municipalities as regards disaster risk reduction policies and their outcomes within the national framework.

Furthermore, KMSs are used as tools to aid in decision-making processes: they may display the limits of policies and justify research as well as political decisions on how to integrate them into decision-making processes at the local level. Many examples of feedback on the use of KMSs are found: in the USA (Renaud et al. 2013: 140–162) and in South Africa (Renaud et al. 2013: 164–189). In all cases, these tools are presented as particularly useful, especially when the limits of research and disaster prevention policies are recognized: "planning for hazard mitigation and adaptation can be challenging when there is much uncertainty and disagreement about the best management practices to minimize risks" (Renaud et al. 2013: 155). Also, the use of KMSs has tended to increase and is now supported by UNDRR.

3.3 The Use of Knowledge Management Systems Also Has Limitations

The ONRN is basically a tool coming from two major stakeholders imbedded in disaster prevention in France: the French state and insurance companies. Therefore, the use of KMSs to help local decision-making, while integrating information and knowledge of local actors in the process, is much more difficult to achieve. Assessments and decisions made while using the ONRN tool can also pose many problems of acceptance. Above all, one cannot expect from the RPP (risk prevention plan) requirements to eliminate entirely future damages, as well as one cannot expect a dike to totally eliminate the risk of flood. Integrating other types of information and knowledge coming from local stakeholders into the decision-making process must be a key requirement. Another major question concerns the poorest households, for whom the issue of adaptation and its limits is secondary, if not even improper, compared to other types of risks they face that are more immediate.

In so doing, the limits of KMSs are identified and even denounced. This is certainly the tool that allows fighting against one of the elements that acts in the favour of disasters, namely, institutional segmentation as well as the fragmentation of information, which together reduce the capacities to learn more from the past. But

it is also a tool that, though certainly not alone, fails to reconsider the key underlying drivers associated with the social construction of disasters.

4 How to Increase the Capacity to Learn from the Past?

Consequently, ambiguous statements on the capacities to learn from the past in spite of evolving disaster prevention policies and tools are found. Some questions would be as follows:

(i) Why does not humankind learn more from past disasters in spite of existing information?
(ii) Who learns for what reason, and what type of information is used to learn from the past?
(iii) Why experiences *identified* from previous disasters (often referred to as lessons *learned*) are often untested or not applied in plans to cope with similar future hazards?
(iv) What can be done in order to assure that societies *retain what they learn* from "experience return" and to enhance the recall of societal knowledge, use and management?

A first choice could be to avoid presenting disasters from the viewpoint of losses only, which in fact does not fully acknowledge the "creeping" increases in value of assets that can be affected at some point in time in the future (e.g. as identified for Atlantic hurricanes by Pielke Jr and Landsea 1998). Indeed, the assessment of mortality should take under consideration the demographic growth of population in exposed areas and the same for economic assets such as livelihoods and the built environment. In spite of methodological problems previously mentioned, the comparison of losses with assets and mortality potential should draw attention to the capacity to prevent and to learn from the past, in spite of the limitations of this capacity. In addition, presenting losses only tends to draw attention to one albeit motivating aspect of disaster understanding and managing limitations, the "dread factor". An overfocus on losses can overshadow prevention and preparedness approaches in the same way that focusing on climate change adaptation or mitigation fails to draw needed attention to climate change prevention.

Those drawbacks highlight the difficulties to display the positive contribution of prevention policies to disaster reduction. Indeed, disaster databases register failures and not the capacity to prevent, as the latter is by far more difficult to prove, less spectacular and less disruptive. If effective, disaster prevention is hardly seen and needs to be proven, as, by definition, nothing happens or damages experienced are lower in intensity and can be managed by using only local resources. Proving the effectiveness of disaster prevention policies requires turning to a "what if" reasoning type. On the contrary, the occurrence of a disaster immediately calls forward the limitations of disaster prevention and of learning from the past.

What would disaster assessments be like at the global scale in the absence of prevention policies? One solution would be to draw attention to the importance and relevance of having a more balanced overview of trends concerning losses, while including assets. It makes sense to call for a way to highlight disaster prevention, as a part of "experience return". This shortcoming draws attention to major constraints, helping to explain why the capacity to learn from the past exists but remains so much limited.

5 Eluding Three Main Pitfalls of Fragmented Risk Research by Contextualizing

Numerous approaches advocate situating risk in social contexts (Wisner et al. 2004; Lewis and Kelman 2012) as well as drawing "timescapes" of risk (Fra.Paleo 2019) or trajectories of vulnerability (Magnan et al. 2012). Critics of resilience also stress the need to involve contextual effects in the analysis, whether institutional or social (Reghezza and Rufat 2015) or, again, related with time and rhythms (Nobert et al. 2017). The way of considering risk or resilience also depends on underlying social, political, cultural or technical frameworks that stand for particular ideologies (O'Brien et al. 2007; Walker and Cooper 2011; Cote and Nightingale 2011). It is important to convey underlying ideological frameworks openly, as they can shape the production of knowledge, as well as the kind of solutions that can be explored. Underlying frameworks and drivers also influence risk conditions (García-Acosta 2005).

It is one thing to identify underlying mechanisms as root causes involved in the fabric of risk, but implementing consequent responses always faces multiple difficulties (Pigeon and Rebotier 2016). In spite of always being limited, knowledge for reducing risk and improving resilience makes sense in specific circumstances. It requires an effort of contextualization, for enlightening both the production of knowledge as well as the fabric of risk situations.

Thus, drawing on "experience return", attention must be paid to causality, complexity and standardization in producing knowledge as well as in considering frameworks of action in managing risk and strengthening resilience. On this basis, a situated approach of disaster risks and prevention policies is suggested to embed contextual effects in assessing and managing risk as well. It should help to identify and reduce pitfalls related to knowledge and management, as well as limitations that DRR policies encounter.

5.1 Main Pitfalls of Fragmented Risk Research: Causal Links

In spite of so many feedbacks, risk research is often framed by classical rationality, at the basis of modern science. Descartes' systematic approach applies when addressing risk in a fragmented way, separating its components into isolated subparts (second principle of the method); when linear or direct causal links are looked for, from the simplest relations to the more complicated ones (third principle of the method); or when generalization – if no universalization – of the analysis of the social world is at stake (fourth principle of the method). Each one of those principles of classical rationality is echoed in most risk research and management.

A classical definition of risk consists in combining hazard and vulnerability (Dalezios et al. 2017). It roughly separates society and the environment and suggests that knowing better any of those elements improves risk knowledge. In that view, a prior and almost self-evident element comes from the environment. As an – apparently – obvious triggering driver of a disaster, the natural event stands as a starting point of the analysis, shaping consequent research on risk and reducing the study area to the impacted area. Risk prevention plans in France rely on different kinds of hazard. Flood risk prevention plans (PPRI) or technological risk prevention plan (PPRT) identifies – often isolated – potential events as starting points of the problem to be addressed. The analytical and functional efficiency of such regulatory plans is counterbalanced by their inability to account for multi-hazard situations and the diversity of stakeholders concerned (Pigeon et al. 2018).

In a classical perspective, understanding simple causal links supposedly offers a method to grasp complicated risk situations. Yet, experience shows that simple causal relations do not exist in risk situations, except when risk situations are fragmented in isolated subparts that lose its actual interactions. On the one hand, there is no way to establish a cause and effect relationship between hazard and losses (part 1). On the other hand, two very similar hazards do not have similar consequences when they occur at different time or in different places. In La Faute-sur-Mer, in western France, many similar storm surges already happened in the past, even in recent years, without causing losses and deaths like in 2010, in the opportunity of the one called Xynthia (Feuillet et al. 2012). Territorial characteristics like the growing number of assets at stake do not explain such a dramatic balance by their own. A possible understanding lies in complex mechanisms that support interactions or positive feedbacks, which are hard to disentangle at first sight (Pigeon 2012).

Finally, when focusing on a trigger event, often outside of the social world, hazard-polarized research loses critical and political criteria when analysing risk situations. It also classifies the world according to potential trigger events. In an illusory way, it might even pretend to account for any kind of possible causes of disasters to be addressed on a systematic base. Universalization of causal processes organizes EM-DAT database of disasters, and an inventory of triggering events organizes part of the *At Risk* book (Wisner et al. 2004). In view of benefits and limitations, how can it be explained that such a classical and fragmented way of

understanding risk remains that significant? The importance given to rather neutral conceptual frameworks can be mentioned; the need to broadly communicate knowledge on risk by engaging in broadly shared categories, even at the price of later deconstruction; but also the difficulty to address complexity, to account for ambiguities and slight differences between specific cases and broader contexts, to give sense to the diversity of interests, power and economic relations at stake in a radical understanding of risk situations.

5.2 Main Pitfalls of Fragmented Risk Research: Complexity

Complexity disrupts causal and stable conceptions and introduces the need to think about systemic relations. Experiences show how important it is to consider the fluctuation of social and territorial systems when understanding risks and trying to reduce them. Complexity is defined as "a quantitative phenomenon, the extreme quantity of interactions and intrusions between a very large number of units". "However, the complexity does not only consist of quantities of units and interactions which defy our possibilities for calculation: complexity also consists of uncertainties, vagueness and random phenomena" (Morin 2005: 48). This way, it is possible to give sense to the diversity (sometimes the contradiction) of the links that make a system exist or to account for provisional and constantly adjusting mechanisms involved in the fabric of risks.

Chanaz and Culoz are two neighbouring municipalities in France, on each side of the Rhône river. They face very similar flood conditions. But more than flood hazard, urbanization, territorial dynamics, competing interests in each municipality and differentiated interests converging with the ones of important institutional, private and public actors at other scales allow understanding the opposite management of risk shown in one place and the other. On fragmented and isolated basis, it is hardly possible to explain why different risk management is different that much in apparently similar risk conditions. An integrated and situated analysis of risk conditions and its contexts gives room to complexity and contextualization over time, between places and among a particular set of actors (Pigeon et al. 2018).

A more complex reading of risk situations is appropriate to embed risks in broader contexts. Accounting for spatial and temporal scales broadens the scope far beyond a sole kind of actors or the area of impacts only. It addresses mechanisms of the fabric of risks far beyond triggering events and allows identifying underlying drivers as well as socially or politically rooted mechanisms (Lewis and Kelman 2012). In line with the radicals, the complexity and embeddedness of the elements involved in the fabric of risks can be addressed on different basis, like through the study of "trajectories of vulnerability" (Magnan et al. 2012). Up to a certain point, resilience offers possible answer to the fluctuation of social and territorial systems as it is an advocate for the ability of a system to absorb a perturbation and to mitigate potential damage without questioning its original structure. Yet, on the ground, the will to return to the normal stance as soon as possible is often the rule, in spite

of so many returns of experience concerning build back better processes. Key issues are displaced more than solved, as the normal stance is a convention constantly updated (Kelman et al. 2016; Fra.Paleo 2019). In front of such a volatile basis for assessing and managing risks and considering the promises of resilience, which are criticized both in general (Cote and Nightingale 2011) and particular terms (Nobert et al. 2017), giving room to complexity may be a condition to account for significant aspects of the fabric of risks and to learn more and better from past experiences.

5.3 Main Pitfalls of Fragmented Risk Research: "One-Size-Fits-All" Viewpoints

Finally, standardization of best practices and kind of homogenization of research perspective pretend to learn from different experiences and be valuable for reducing risk in more general terms. Yet such a generalization faces two pitfalls at least: it tends to overlook contextual specificities, and it carries specificities of past experiences that do not make sense necessarily at present, anywhere or for future situations. Generalization of standard assessment and responses comes from the need to broadly address risk issues, for instance, through a framework of actions. Yet, neither risk assessment nor risk reduction can be considered out of any territorial context. Even if it may be accepted that science relies on universal principles, knowledge (and action) remains highly context-sensitive.

Literature and lessons from past experiences show how important it is to embed risk situations in historical structures, in scales of time and space (Kelman et al. 2016; Lewis and Kelman 2012; Wisner et al. 2004). Elements of interpretation and risk drivers must be found necessarily out of the moment of the disaster and out of the area of impacts. Such an idea is at the base of the territorial vulnerability approach (D'Ercole and Metzger 2009). It states that knowing well the territory at stake gives significant elements to understand risk situations and potentially to manage them. Stressed by the need to act, ticking boxes of frameworks' expectations or in guidelines' steps of action looks like a goal by itself. It disregards local conditions and contextual specificities that appear so meaningful in understanding risk situations and managing them. Instead of standing as an ideal (almost metaphorical) future of lower risk or a desirable goal to achieve thanks to an accurate risk assessment and management (Alexander 2013), good practices (in absolute terms) turn to be the rule and disregard specific conditions. Contexts are not a limitation to disaster risk prevention policies. They are conditions for action and stand as a starting point for knowledge and management. This is the meaning of the approach exposed in the following subsection.

6 Territorializing Risk: A Means to Fight Against Fragmentation

6.1 What Does Territorial Approach of Risk Mean?

Territorializing risks consists of an integrative framework that accounts for physical aspects of risks as well as for its representations, conceptions and discourses, be they related with scientific work, prevention policies or social perceptions. Territories are not only areas under control, but they also correspond to social constructions. They concern a piece of space whose fuzzy frontiers depend on social meanings and identification, on appropriation and symbolic dimensions. They also realize competing interests between actors, or institutions, by making them tangible either materially or on a more speculative basis in the social world. Inspired of French social geography (Antonsich 2011; Jean and Calenge 2002), a territorial approach defines a way to address social issues as they are rooted in space, over time (in a sequence of historical events, Pred 1984) and within society (accounting for uneven relations among social actors).

Risk situations show spatial dimensions that can be assessed through the lens of a territorial approach. Territorializing risk allows setting a dynamical framework to assess risk situations. It articulates them to a contextualized sequence of events proper to a place, a set of actors and their interests (Simon and Dooling 2013). The uneven distribution of territorial characteristics (in terms of space, time and social stratification or competing interests) is reflected in the endless combination and diversity of risk drivers. Thus, not to multiply the analysis of singular case studies, territorializing risks allows shedding light on recurring causal mechanisms of risk fabric that involve territories and its necessary situation in time, over space and among the complexity of the social world (Rebotier 2012).

Two main directions can be considered to set the ground to a territorializing approach that contextualizes risk situations, knowledge on risks as well as the way it is produced (Jasanoff 1998; Pestre 2006).

6.2 How to Territorialize Risks?

A two-step approach can be defined. The first step is twofold and considers risk situations. The second step implies accounting for the conditions of knowledge production about risks.

As for the first step, it is important to draw a comprehensive network of the actors who interact on the territory at stake (even from different scales), and how meaningful are what kind of territorial characteristics and for whom. Such a broad reading of a territory might look misleading for risk research, but there is no doubt that many of the significant risk drivers, the ones that shape not only risk situations but also disasters, are rooted in territorial characteristics (D'Ercole and Metzger 2009)

and can be found outside of the reductionist perimeters defined by the area of potential impacts (Lewis and Kelman 2012). Once the main criteria are identified (depending on the specificities of each territory at stake), it is possible to address interactions and mechanisms at work between them. How do such significant territorial criteria turn concrete? How important are they in defining risk situations? In concerning uneven pieces of space or social sectors? Main concerns ask for what makes people or places vulnerable, regarding territorial characteristics and its interactions. It embeds risk situations in the contextualized understanding of territories.

But as for the second step, even if scientific principles might be considered as universal, there is no such thing as universally valid knowledge in social sciences, as the social world is sensitive to space, time and social context. Such a distinctive preliminary view brings epistemological consequences, as the status of the scientific proof (potentially falsifiable) is different for non-empirical sciences (Pigeon and Rebotier 2016: 143–147). The knowledge produced differs from experimental science mechanisms. It does not correspond to any kind of truth made visible or understandable through a positive scientific process. It is rather a set of interpretative meanings, making sense according to a specific context, that potentially echo main structures (or recurring dynamics) accounted for in other experiences. Producing knowledge in social sciences on territories goes through an iterative process of consolidation, by multiplying the observations in front of a continuously evolving framework of a broader explanation of the phenomena at stake (Passeron 1995). And, as with any social activity, production of knowledge is sensitive to social, political, institutional and economic conditions in which it is produced (Bourdieu 2001).

That is why territorializing risks concerns not only risk situations and its contexts but also the way knowledge on risks is produced, by who, fulfilling which interests, on the basis of which conception of risks, etc.

6.3 Territorializing Risks: The Example of Esmeraldas, Ecuador

A research experience in Esmeraldas provides an example of the importance of contextualizing risk situations (Pigeon and Rebotier 2019), following the two-step approach.

The city of Esmeraldas, in northern Ecuador, on the Pacific coast, hosts strategic oil assets for the country. At the same time, the site is very exposed to high-intensity earthquakes associated with potential tsunamis, and the local government shows very low capacities for dealing with such risk conditions, in spite of being the municipal level at the forefront of the national strategy for managing risks (Rebotier 2016). The risk situation in Esmeraldas is worsened by a deeply fragmented governance of risks and planning. Yet, such a paradoxical situation can be better understood by shedding light on significant contextual characteristics, as political history

of Esmeraldas province in Ecuador; the cultural and symbolical status of Afro-Ecuadorian population of the province; the conflictive relationship between Quito and Guayaquil, being Esmeraldas at the crossroad of the competition; the late territorial integration of the province to the rest of the country; the strongly centralized management of oil sector in spite of a budding process of decentralization; etc. A good understanding of territorial dynamics gives insights to enlighten influential mechanisms that give rise to particular risk situations in one place, at one moment, in a particular social context. These risks can shift over time.

The same research experience in Esmeraldas shows the importance of acknowledging contextual conditions of the production of knowledge on risks (Rebotier et al. 2019). When studying earthquakes in pre-instrumentation periods, seismologists are bound to consider different kinds of proxies to shape important physical characteristics as magnitude or location of past events. Such reconstructions for pre-instrumentation periods are important for knowing better regional characteristics of seismicity (Nocquet et al. 2017). Seismologists use proxies coming from geomorphology or paleoseismology, but they also use historical archives giving information on damage intensities (Beauval et al. 2013). Historical archives on damage description (mainly writings by diplomats, merchants or clergymen) must be reliable enough to be considered in the shaping of past earthquakes. The more historical archives that are found, the more consistent the information looks, and the more robust can results be considered for geoscientists. Yet, as for a marginal region like Esmeraldas province, historical archives are not offering the same contextual conditions than the ones in the early occupied Sierra region. On the one hand, the fact that no (or a few) expression of damage is found in the northern Ecuadorian coast does not mean that no earthquake happened. On the other hand, the status of historical archives describing past damage in Esmeraldas is different from the one of the archives found in the Sierra, close to long-standing places of secular and religious powers. Not even considering the social conditions of producing knowledge (Haraway 1988), historical data considered in seismology requires being duly contextualized in order to make full sense and not to mislead the analysis. Contextualization and the fight against fragmentation can be applied to another thematic scope.

7 Fighting Against Fragmentation: Opportunities and Challenges Related with DRR-CCA Integration

7.1 Why Reconsider the DRR-CCA Divide?

"Best practices" represent a popular concept used for planning to prepare for and respond to hydro-meteorological and geohazards in the future, based on assessments of lessons drawn from previous disasters. This is a useful approach, if all socio-economic, political and demographic conditions as well as behaviour of

hazards stay the same over time. “Best practices” work in theory. However, everything noted above changes sometimes in predictable ways and sometimes in surprising ways. Because of increasing human-induced greenhouse gas emissions, the global climate is heating up. The warming of the atmosphere is increasingly generating – over a long term and in a low-grade, incremental and cumulative way – more frequent, more extreme hazards in new locations as well as in historical ones. Existing “best practices” will be short-lived and may even fail under a warmer atmosphere. At the least, they must be monitored and re-evaluated for appropriateness under a warmer climate. Although many people may not see it, societies are “at war with their changing climate”.

The natural hazards research community has a proverbial elephant in the room: the elephant is the warming global climate. The warming is a result of increasing greenhouse gas emissions as a result of human activities. For decades the natural hazards research community has worked on disaster risk reduction (DRR) separately from the climate change adaptation (CCA) research community. This was in large measure because the IPCC, since the early 1990s, focused mainly on the science of climate change (e.g. the IPCC’s working group I) at the relative expense of research on its societal and environmental impacts (working group II) and policy implications (working group III). WG II belatedly received the attention it deserved and at first heavily focused on environmental concerns and later on societal implications of environmental changes that would likely accompany a warmer atmosphere many decades in the future. However, climate researchers are seeing now some of those climate change-related impacts expected decades in the future, such as the rapid melting of Arctic sea ice, the melting of Greenland ice, record-setting flooding and heatwaves. Scientific estimates of expected adverse environmental changes affecting societies by, say, 2050 are beginning to appear now. This suggests that many of the adverse impacts of a changing climate expected in the 2050s are beginning to occur: the climate impacts of the 2020s are perhaps becoming the climate impacts expected of the 2050s. Thus, it is time for the natural hazards and the climate change research communities to join forces and resources *where their concerns overlap*.

The following pages present a brief overview of the possibilities for and problems encountered in efforts to bridge, blend or integrate DRR and CCA (See Glantz et al. 2014; EFDRR 2016; Ramasamy 2016). These two communities would each benefit from identifying *how to blend their common (overlapping) activities*.

7.2 Similarities Between CCA and DRR Should Help Merging Both Issues

Even though their missions focus on very different time frames and have different tasks, different sources of funding and even different vocabularies, the following concerns among others are shared by both DRR and CCA.

DRR and CCA both:

- Seek to reduce if not avoid risk to hydromet and geohazards
- Seek to foster adaptive capacity
- Seek to foster societal resilience
- Face an uncertain climate future (e.g. climate water and weather variability, change and extremes)
- Have (share) overlapping but different time frames (short to midterm; midterm to longer term)
- Focus on hydro-meteorological hazards
- Could benefit from each other's knowledge
- Seek to reduce vulnerability of at-risk populations
- Are concerned about rural development
- Are concerned about hazard risk management (but on different timescales)

It is important to note that all DRR activities have a CCA component and all CCA activities have a DRR component. Commonalities between the two fields include concern with improving disaster response, reducing societal vulnerability and increasing resilience. Both the DRR and the CCA communities are focused on climate-, water- and weather-related disasters: the DRR community because it is its core concern; the CCA community because planning for future disasters has become a primary concern for policymakers. The DRR community has traditionally placed greater emphasis and resources into anticipating and preparing for educating the public about how communities could more effectively cope with the hydro-meteorological hazards that they currently face.

Communities armed with knowledge about preparedness and DRR can be expected to better fend for themselves in a direct threat from a known hydro-meteorological hazard. In a way, humanitarian organizations are forced by circumstances to undergo "mission creep" toward CCA issues in order to effectively fulfil their mission of protecting life, livelihoods and property under a changing climate and the extremes it might bring. For its part, the longer-term climate change (CCA) and sustainable development community's activities have been greatly influenced by today's news headlines about the growing threat of hazards becoming societal disasters in addition to its focus on wide-ranging impacts of global climate change.

Although there is a fuzzy boundary between CCA and DRR research missions, the first decade of the twenty-first century witnessed an increasing number of CCA projects dealing with contemporary hazards, which was the beginning an *overlapping of activities* that traditionally had been undertaken by DRR researchers. Preparing society for future climate change and preparing it to reduce weather-related hazard risks are quite similar. Both communities involve ongoing processes that include information generation, awareness raising, planning and monitoring (Klein et al. 2003). Adaptive capacities have to be considered in both approaches; however, CCA by definition focuses on longer-term issues such as sustainable development much more so than does DRR. As such, adaptation, originally promoted with regard to future climate change impacts, has slowly moved toward undertakings that also manage present climate hazard impacts. This transition by

CCA to focus attention and resources on present-day hazards has been justified by the growing awareness of global warming's association with current climate extremes.

7.3 Challenges Raised by Differences Between CCA and DRR

CCA is concerned about identifying ways for societies to adapt sustainably to an increasingly warmer climate over decades. However, coping with disasters is only one of several key concerns of the CCA community: reducing carbon emissions (mitigation), adapting to changing environmental conditions, developing non-polluting energy sources, protecting tropical forests, modelling and monitoring atmospheric changes and so forth. Its direct involvement in disaster preparedness is an example of the CCA community's "mission creep" into today's DRR's mission of disaster preparedness planning for regional and local climate, water and weather extremes.

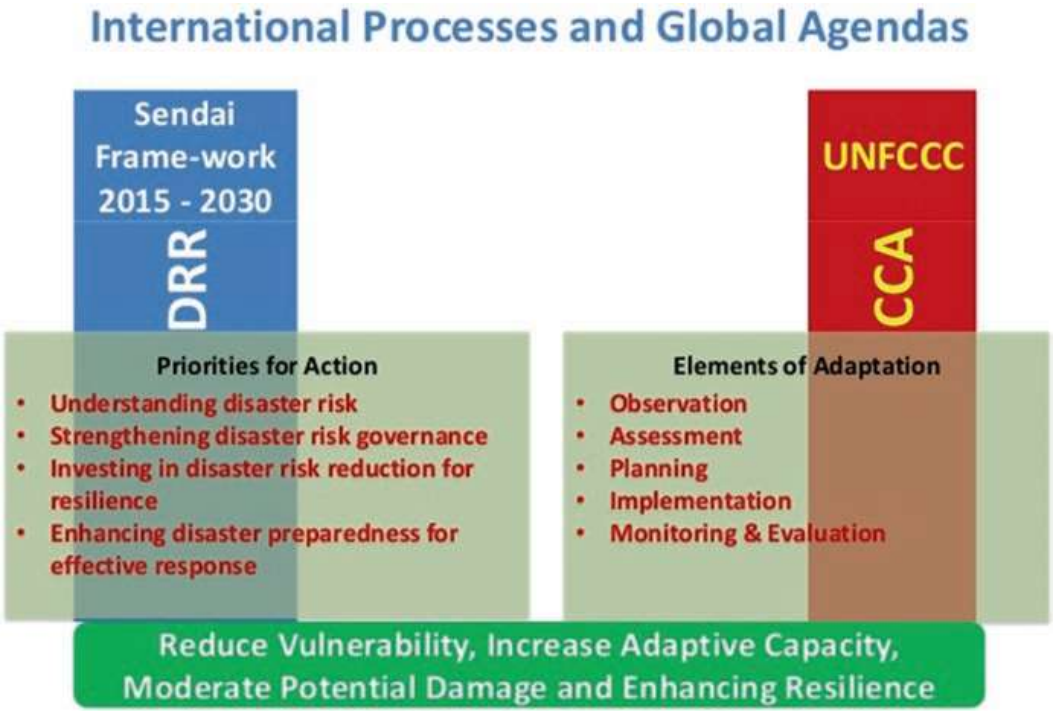
Several researchers (Mitchell and van Aalst 2008; O'Brien et al. 2008; Shaw et al. 2010) argued that CCA's more future-looking perspective will be essential to ensure that DRR activities remain viable in the face of climate change. In this way, CCA researchers may also consider slow-onset (creeping) environmental changes such as the incremental rising sea level, loss of biodiversity and changing water resources (Shaw et al. 2010) as well as consider the end result of such accumulating incremental environmental changes.

There are also significant differences in the tools and approaches both CCA and DRR use in addressing hazards. DRR has a history of interventions and specific tools such as case studies that have yet to be well-developed in CCA (Mitchell and van Aalst 2008; O'Brien et al. 2008). DRR also has a tradition of including local actors and local knowledge, whereas CCA has largely been dictated by global policy processes and scientific guesstimates about impacts throughout the rest of the twenty-first century.

CCA proponents sometimes suggest that DRR programmes that seek to "get life back to normal" to "build back better" or to "bounce back" are short-sighted in that their tendency is to rebuild communities by getting life back to normal as soon as possible but still poverty-stricken and in the same risky locations: they raise tents where houses were and place trailers where schools or other municipal buildings were in pre-disaster days. CCA proponents often critique such DRR actions as examples of "unsustainable development" or even as maladaptation to a changing climate. Yet disaster victims often want to return to a semblance of normalcy, risky conditions notwithstanding, at least for the immediate and short- to midterm future. Doing so may be a viable tactical objective, as it provides more time for the CCA community to identify ways to move settlements out of harm's way or to protect them from the foreseeable hazards they will face if they remain in harm's way.

7.4 What Might Be Gained by Integrating DRR and CCA

Potential synergies between the fields of DRR and CCA provide compelling reasons for greater communication between the two fields as well as for each to adopt elements of the other in the name of both efficiency and effectiveness. For example, CCA might benefit from tools already established by DRR, including methods for engaging local communities, while keeping its focus on long-term vulnerability reduction. Conversely, DRR could benefit from CCA's proactive approach toward sustainable development, which might better ensure that both risk reduction and disaster relief programmes incorporate changing climate scenarios into their programmes and actions. Assuming a longer-term perspective within the field of DRR could increase the societal resilience of projects that will eventually be affected by climate change.



Ramasamy, S. (2016). Disaster risk reduction (DRR) and climate change adaptation (CCA)

7.5 What Might Be Lost in a Merger of CCA and DRR

Disasters and DRR are usually conceptualized in terms of human losses not environmental losses (i.e. biodiversity, coral reefs, etc.). Climate change adaptation emphasizes loss of resilience in biological systems more so than DRR, which tends to be strictly anthropocentric in its focus. Merging the two, however, runs the risk

that climate change would become the primary focus to the detriment of other hazard-related sources of vulnerability. Also, how climate change will affect specific locations might lead to greater paralysis of action, given scientific uncertainties. There is also a risk that political support for funding DRR might be undermined in areas where the climate change issue is still politically contested, as in the USA today.

It would be interesting to explore how political support for CCA and DRR is mobilized in order to see if integration might inadvertently undermine support for one community or the other. To be sure, the values underlying each separate approach are certainly worth considering before a merger or *blending of overlapping concerns* is carried out. One might argue, for example, that CCA, being situated within environmental ministries because it is largely being framed as an environmental issue, draws strength from "ecocentric" values and its strong support from the environmental community. In contrast, with its roots in humanitarian relief, DRR is more oriented toward disaster prevention, preparedness and relief of human suffering.

7.6 Targeting Institutional Fragmentation

Several researchers argue that integration would open space for each field to learn from the strengths and weaknesses of the other and contribute to more efficient use of resources (Shaw et al. 2010; Tear Fund 2008). One of the primary challenges facing humanitarian and development organizations is redefining the relationship between disaster risk reduction (DRR), climate change adaptation (CCA) and other kinds of development frameworks. There has been a growing recognition in the areas of complementarity (Red Cross and Red Crescent 2013) and in tensions between these fields, as well as calls for greater integration between them (Shaw et al. 2010; Tear Fund 2008). Calls for "mainstreaming" DRR and CCA within development more generally have often been made (O'Brien et al. 2008; Schipper 2009; Schipper and Pelling 2006; Mitchell et al. 2006).

A complete integration of institutions governing DRR and CCA research and policy is unlikely because of power disputes between various entrenched research organizations or among various units within them. Other principle challenges to integration include fragmentation of funding and implementation of resources, entrenched interests, different spatial and temporal scales, differing systems of norms and different kinds and sources of knowledge (Birkmann and von Teichman 2010). In particular, reconciling the top-down CCA agenda, which is driven by multilateral organizations, and bottom-up with the local approach common to DRR may be especially difficult.

Currently, agencies, funding sources and approaches are largely separate. Much DRR funding comes from humanitarian budgets, whereas most funding for CCA comes from environmental ministries. Such separation has also meant the development of different terminologies, which further complicates cooperation and

communication between the two fields. For example, "mitigation" in the context of climate change refers to a reduction in CO_2 emissions, whereas in DDR it is taken much more broadly, referring to efforts to reduce potential damages from known natural hazards (Schipper 2009).

Bridging requires changes in the way these groups meaningfully interact; they can no longer remain as autonomous sub-fields of operation sometimes even within the same agency. Resistance to bridging results primarily from the following factors: the two communities have different mandates, they are focused on different aspects of development, they have differing missions, they have different time frames of concern, they employ different approaches to fulfilling their missions, they require different resource streams and amounts, they have different ways to access funds, and they have different time frames for evaluating success or failure. Bridging these two communities will be easier said than done, even though *they have shared overlapping interests in addressing disasters today and in the future*.

This shift in mindset and approach to make humanitarian and longer-term development activities more beneficial to donors and recipients alike will take some time to implement to the fullest extent. Only time will really tell, as sustainable outcomes are seldom identified overnight. Discussion continues about how to link, complement, bridge, blend or integrate DRR and CCA, the two autonomous development-related mandates. One possible example to foster their interactions would be to establish a common pool of funds that is solely to support those activities in which the DRR and CCA communities truly overlap and on which they truly collaborate.

Boxed Inset

As an example, it can be suggested that there are "gateway" concepts that enhance DRR activities designed to cope with present-day climate-, water- and weather-related impacts, while keeping future CCA needs in mind. El Niño-ready nations is such a gateway concept that not only bridges DRR and CCA but also allows for the blending of their overlapping activities. It is not possible to avoid addressing the changing climate factor, when it comes to making countries El Niño ready.

The history and contemporary monitoring of El Niño in the tropical Pacific are more useful than just preparing for an impending episode itself and its teleconnected environmental and socio-economic impacts. It is what it is called a gateway (bridging) concept because it links the past and present to the future. Our reasoning is as follows: because El Niño events have an average return period of 4½ years, societies affected by it can prepare for it both tactically and strategically, as a nation's funds permit. It can be shown that El Niño events serve as lab experiments quasi-periodically where favourable preparations and responses to previous events can be evaluated and strengthened and weaknesses identified and addressed. It serves as a "canary in the mine" for

societal institutions' and communities' prevention and preparedness for coping with a changing climate.

As the global to local climates change, a society's best practices will also be changing. As climate change so far has been incremental, a creeping environmental change, monitoring El Niño can glimpse such changes and, hopefully, spark and test societal adjustments (acclimatizations) as early as possible. The study of El Niño and its impacts is one example of other potential gateway concepts and notions that must not be divorced from studies of the earth's changing climate. Focusing on the El Niño phenomenon as a bridge can blend mutual concerns about present-day hazards (DRR) with those for sustainable development (SD) and, more specifically, about climate change adaptations (CCA) that will be needed in future generations.

8 Summary and Conclusions: What to Do to Improve the Existing Situation?

Learning from the past is a key aspect for the well-being of humankind in the future. Learning is key for societal improvement to avoid natural and human-generated disasters. Learning alone, however, cannot lead us to the perfect one and forever solution, because natural, environmental and societal processes are each dynamic and their combined interactions often yield unanticipated concerns.

It is common sense to assess existing as well as past disaster-related situations, as it concerns disaster risk reduction prevention and preparedness policies with an eye on possible changes in the future. There is a collective societal hope and expectation that it really is possible to be better prepared for future hazards and the disasters they generate. This is generally acknowledged through the gateway concept of the "learning curve". But difficulties in assessing results from prevention and preparedness measure gains are reflected by the numerous shortcomings of various tools such as databases, models or knowledge management systems. They enlighten, but at the very same time, their relevance and usefulness for decision-making have inherent challenges.

Two main pitfalls are epistemological and institutional. Basically, they arise from the basic need to understand and then to manage complexity, while reducing analytical and institutional fragmentation where possible. It requires taking into consideration more types of risk and bringing local stakeholders into hazard-related decision-making processes. Limitations are not a dead-end for managing risk because they are part of risk management. They should be acknowledged through "gateway" concepts and approaches, like territorialization. Hazard and disaster institutions as well as political decision-makers must rise to the challenge.

Acknowledgement The authors acknowledge Robert Jay Ross, CCB, for his support in the preparation of this paper, and Prof. Saeid Eslamian, Center Director of Excellence in Risk Management and Natural Hazards, Isfahan University of Technology, for his assistance in editing the chapter.

References

Alexander, D. (2013). Resilience and disaster risk reduction: An etymological journey. *Natural Hazards and Earth System Sciences, 13*, 2707–2716.

André, C. (2013). *Analyse des dommages liés aux submersions marines et évaluation des coûts induits aux habitations à partir de données d'assurance. Perspectives apportées par les tempêtes Johanna (2008) et Xynthia (2010)* (Thèse de doctorat en géographie). Université de Bretagne Occidentale, Brest, France.

Antonsich, M. (2011). Re-thinking territory. *Progress in Human Geography, 35*(3), 422–425.

Beauval, C., Yepes, H., Palacios, P., Segovia, M., Alvarado, A., Font, Y., Aguilar, J., Troncoso, L., & Vaca, S. (2013). An earthquake catalogue for seismic hazard assessment in Ecuador. *Bulletin of the Seismological Society of America, 103*(2A), 773–786.

Beck, U. (2001 [original: 1986]). *La société du risque. Sur la voie d'une autre modernité*. Paris, France: Aubier-Flammarion.

Berkes, F., & Folke, C. (2002). Back to the future: Ecosystem dynamics and local knowledge. In L. H. Gunderson & C. S. Holling (Eds.), *Panarchy: Understanding transformations in human and natural systems* (pp. 121–146). Washington, DC: National Academy Press.

Birkmann, J., & von Teichman, K. (2010). Integrating disaster risk reduction and climate change adaptation: Key challenges – scales, knowledge, and norms. *Sustainability Science, 5*(2), 171–184.

Boissier, L. (2013). *La mortalité liée aux crues torrentielles dans le sud de la France: Une approche de la vulnérabilité humaine face à l'inondation* (Thèse de doctorat en géographie). Université de Montpellier, Montpellier, France.

Bourdieu, P. (2001). *Science de la science et réflexivité*. Paris, France: Raisons d'agir.

Cazaux, E., Meur-Ferec, C., & Peinturier, C. (2019). Le régime d'assurance des catastrophes naturelles à l'épreuve des risques côtiers. Aléas versus aménités, le cas particulier des territoires littoraux. *Cybergeo: European Journal of Geography* [En ligne], Espace, Société, Territoire, document 898, mis en ligne le 23 mai 2019, consulté le 02 juin 2019. URL: http://journals.openedition.org/cybergeo/32249.

Cote, M., & Nightingale, A. (2011). Resilience thinking meets social theory: Situating social change in socio-ecological systems (SES) research. *Progress in Human Geography, 36*(4), 475–489.

CRED. (2019). *Base de données EM-DAT*. http://www.emdat.be.

D'Ercole, R., & Metzger, P. (2009). La vulnérabilité territoriale: Une nouvelle approche des risques en milieu urbain. *Cybergeo: European Journal of Geography* [online]. http://cybergeo.revues.org/22022.

D'Ercole, R., Hardy, S., & Robert, J. (2009). Balance de los accidentes y desastres ocurridos en La Paz, Lima y Quito (1970-2007). *Bulletin de l'Institut Français d'Études Andines, 38*(3), 433–465.

Dalezios, N. R., Tarquis, A. M., & Eslamian, S. (2017). Chapter 5 droughts. In N. R. Dalezios (Ed.), *Environmental hazards methodologies for risk assessment and management* (pp. 177–210). London: International Water Association Publishing.

EFDRR. (2016). *How does Europe link DRR and CCA? Working paper*. Working group on Climate Change Adaptation and Disaster Risk Reduction.

Feuillet, T., Chauveau, E., & Pourinet, L. (2012). Xynthia est-elle exceptionnelle ? Réflexions sur l'évolution et les temps de retour des tempêtes, des marées de tempête, et des risques de surcotes associés sur la façade atlantique française. *Norois, 222*, 27–44.

Fra.Paleo, U. (2019). Timescape of disaster risk governance in contemporary Japan: Neither state of normalcy nor constancy in regulation. *PLoS One, 14*(4), e0215164. https://doi.org/10.1371/journal.pone.0215164.

García-Acosta, V. (2005). El riesgo como construcción social y la construcción social del riesgo. *Desacatos, 19*, 11–24.

Glantz, M. H. (2015). *The Antalya statement – an expert forum on disaster risk reduction (DRR) in a changing climate: Lessons learned about lessons learned*. Convened by USAID, CCB/CU, WMO, TSMS, avec le soutien de NOAA et GFDRR, Antalya, Turkey.

Glantz, M. H., Baudoin, M.-A., de la Poterie, A. T., & Naranjo, L. (2014). *Working with a changing climate, not against it – hydro-meteorological disaster risk reduction: A survey of lessons learned for resilient adaptation to a changing climate*. CCB/INSTAAR. http://www.ccb-boulder.org/1391-2/.

Haraway, D. (1988). Situated knowledge: The science question in feminism and the privilege of partial perspective. *Feminist Studies, 14*(3), 575–599.

Jasanoff, S. (1998). The political science of risk perception. *Reliability Engineering and System Safety, 59*(1), 91–99.

Jean, Y., & Calenge, C. (2002). *Lire les territoires*. Tours, France: MSH.

Kelman, I., Gaillard, J.-C., Lewis, J., & Mercer, J. (2016). Learning from the history of disaster vulnerability and resilience research and practice for climate change. *Natural Hazards, 82*, 129–143.

Klein, R., Nicholls, R., & Thomalla, F. (2003). Resilience to natural hazards: How useful is this concept? *Global Environmental Change Part B: Environmental Hazards, 5*(1–2), 35–45.

Kuhlicke, C., & Steinfuhrer, A. (2010). *Social capacity building for natural hazards: A conceptual frame*. Cap-Haz net report, Leipzig, Germany, Helmholtz Centre for Environmental Research – UFZ.

Lewis, J., & Kelman, I. (2012). The good, the bad and the ugly: Disaster risk reduction (DRR) versus disaster risk creation (DRC). *PLoS Currents Disasters*, Ed.1, *4*, e4f8d4eaec6af8. https://doi.org/10.1371/4f8d4eaec6af8.

López-Peláez, J., & Pigeon, P. (2011). Co-evolution between structural mitigation measures and urbanization in France and Colombia: A comparative analysis of disaster risk management policies based on disaster databases. *Habitat International, 35*(4), 573–581.

Macdonald, N., Chester, D., Sangster, H., Todd, B., & Hooke, J. (2012). The significance of Gilbert F. White's 1945 paper "human adjustment to floods" in the development of risk and hazard management. *Progress in Physical Geography, 36*(1), 125–133.

Magnan, A. K., Duvat, V., & Garnier, E. (2012). Reconstituer les "trajectoires de vulnérabilité" pour penser différemment l'adaptation au changement climatique. *Natures Sciences Sociétés, 20*(1), 82–91.

Menoni, S., & Margottini, C. (2011). *Inside risk: A strategy for sustainable risk mitigation*. Berlin, Germany: Springer, 369 p.

Michellier, C., Pigeon, P., Paillet, A., Trefon, T., Dewitte, O., & Kervyn, F. (2020). The challenging place of natural hazards in disaster risk reduction conceptual models: Insights from Central Africa and the European Alps. *International Journal of Disaster Risk Sciences, 11*, 316. https://doi.org/10.1007/s13753-020-00273-y.

Mitchell, T., Tanner, T., & Wilkinson, E. (2006). Overcoming the barriers: Mainstreaming climate change adaptation in developing countries. https://doi.org/10.13140/RG.2.2.17956.37765.

Mitchell, T., & van Aalst, M. (2008). *Convergence of disaster risk reduction and climate change adaptation*. A review for DFID. https://www.preventionweb.net/files/7853_ConvergenceofDRRandCCA1.pdf.

Mitchell, T., Guha-Sapir, D., Hall, J., Lovell, E., Muir-Wood, R., Norris, A., Scott, L., & Wallemacq, P. (2014). *Setting, measuring and monitoring targets for reducing disas-*

ter risk. Recommendations for post-2015 international policy frameworks. London: Overseas Development Institute, consulté en ligne le 11 janvier 2016. http://www.odi.org/publications/8448-setting-measuring-monitoring-targets-disaster-risk-reduction-recommendations-post-2015-international-policy-frameworks.

Morin, E. (2005). *Introduction à la pensée complexe*. Paris, France: Seuil.

Nobert, S., Rebotier, J., Vallette, C., Bouisset, C., & Clarimont, S. (2017). Resilience for the Anthropocene? Shedding light on the forgotten temporalities shaping post-crisis management in the French Sud Ouest. *Resilience: International Policies, Practices and Discourses, 5*(3), 145–160.

Nocquet, J.-M., Jarrin, P., Vallée, M., Mothes, P. A., Grandin, R., Rolandone, F., Delouis, B., Yepes, H., Font, Y., Fuentes, D., et al. (2017). Supercycle at the Ecuadorian subduction zone revealed after the 2016 Pedernales earthquake. *Nature Geoscience, 10*, 145–149.

Nussbaum, R., & Pigeon, P. (2015). *A national Public Private Partnership (PPP) platform for risk data sharing to stimulate participative governance in France*. UNISDR Scientific and Technical Advisory Group, Case Studies, consulté en ligne le 22 janvier 2016. http://www.preventionweb.net/files/workspace/7935_rnussbaumpppdrrinfrance.pdf.

O'Brien, K., Eriksen, S., Nygaard, L. P., & Schjolden, A. (2007). Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy, 7*(1), 73–88.

O'Brien, K., Sygna, L., Leichenko, R., Adger, N., Barnett, J., Mitchell, T., Schipper, L., Tanner, T., Vogel, C., & Mortreux, C. (2008). *Disaster risk reduction, climate change adaptation and human security*. A commissioned report for the Norwegian Ministry of Foreign Affairs. https://www.unisdr.org/files/7946_GECHSReport3081.pdf.

Olcina, J., Sauri, D., Hernández, M., & Ribas, A. (2016). Flood policy in Spain: A review for the period 1983-2013. *Disaster Prevention and Management, 25*(1), 41–58. https://doi.org/10.1108/DPM-05-2015-0108.

Passeron, J.-C. (1995). L'espace mental de l'enquête (I). La transformation de l'information sur le monde dans les sciences sociales. *Enquête, 1*, 13–42.

Pereira, S., Zêzere, J. L., Quaresma, I., Santos, P. P., & Santos, M. (2015). Mortality patterns of hydro-geomorphologic disasters. *Risk Analysis, 36*(6), 1188–1210. https://doi.org/10.1111/risa.12516.

Pestre, D. (2006). *Introduction aux science studies*. Paris, France: La Découverte.

Picquout, A. (2013). *Impacts géographiques de l'éruption de 2010 du volcan Merapi, Java, Indonésie* (Thèse de doctorat en géographie). Université Panthéon-Sorbonne – Paris I, France.

Pielke, R., Jr., & Landsea, C. (1998). Normalized hurricane damages in the United States: 1925-1995. *Weather and Forecasting, 13*, 621–631. https://www.aoml.noaa.gov/hrd/Landsea/USdmg/index.html.

Pigeon, P. (2012). Apports de la résilience à la géographie des risques: l'exemple de La Faute-sur-mer (Vendée, France). *Vertigo – La revue électronique en sciences de l'environnement, 12*(1), 1–19. http://journals.openedition.org/vertigo/12031.

Pigeon, P. (2013). Flood risk and watershed management conflicts in France: Upper catchment management of the river Rhone. In J. Warner, A. Van Buuren, & J. Edelenbos (Eds.), *Making space for the river. Governance experiences with multifunctional river flood management in the US and Europe*. London: IWA Publishing.

Pigeon, P. (2017). Dike risk: Revealing the academic links between disaster risk reduction, sustainable development, climate change and migration. In K. Sudmeier-Rieux, M. Fernández, I. Penna, I. Jaboyedoff, & J. C. Gaillard (Eds.), *Identifying emerging issues in disaster risk reduction, migration, climate change and sustainable development. Shaping debates and policies*. London: Springer.

Pigeon, P., & Rebotier, J. (2016). *Disaster prevention policies. A challenging and critical outlook*. London: ISTE-Elsevier.

Pigeon, P., & Rebotier, J. (2019). Que nous apprennent les bases de données sur les désastres associés aux séismes? *Physiogéo, 14*, 113–146. https://journals.openedition.org/physio-geo/9036.

Pigeon, P., Rebotier, J., & Guézo, B. (2018). Ce que peut apporter la resilience à la prevention des désastres: exemples en Lavours et en Chautagne (Ain, Savoie). *Annales de Géographie, 719*(1), 5–28.

Pred, A. (1984). Place as historically contingent process: Structuration and the time-geography of becoming places. *Annals of the Association of American Geographers, 74*(2), 279–297.

Ramasamy, S. (2016). *Disaster risk reduction (DRR) and climate change adaptation (CCA)*. Presentation for the Food and Agriculture Organization (FAO), Italy.

Rebotier, J. (2012). Vulnerability conditions and risk representations in Latin-America: Framing the territorializing urban risk. *Global Environmental Change, 22*(2), 391–398.

Rebotier, J. (2016). *El riesgo y su gestión en Ecuador. Una mirada de geografía social y política*. Quito, Ecuador: PUCE.

Rebotier, J., Pigeon, P., & Metzger, P. (2019). Returning social context to seismic risk knowledge and management. Lessons learned from an interdisciplinary research in the city of Esmeraldas, Ecuador. *Cybergeo: European Journal of Geography* [online]. https://journals.openedition.org/cybergeo/31787.

Red Cross and Red Crescent (2013). A guide to mainstreaming disaster risk reduction and climate change adaptation. IFRC.org, Geneva. (pp. 5, passim).

Reghezza, M., & Rufat, S. (2015). *Résiliences. Sociétés et territoires face à l'incertitude, aux risques et aux catastrophes*. Paris, France: ISTE.

Renaud, F., Sudmeier-Rieux, K., & Estrella, M. S. (2013). *The role of ecosystems in disaster risk reduction*. Tokyo, Japan: United Nations University Press.

Revault D'allonnes, M. (1999). *Le dépérissement de la politique*. Paris, France: Flammarion.

Schipper, E. L. F. (2009). Meeting at the crossroads: Exploring the linkages between climate change adaptation and disaster risk reduction. *Climate and Development, 1*(1), 16–30. https://doi.org/10.3763/cdev.2009.0004.

Schipper, L. E., & Pelling, M. (2006). Disaster risk, climate change and international development: Scope for, and challenges to, integration. *Disasters, 30*(1), 19–38.

Shaw, R., Pulhin, J. M., & Pereira, J. J. (2010). Climate change adaptation and disaster risk reduction: Overview of issues and challenges. *Community, Environment and Disaster Risk Management, 4*, 1–19.

Simon, G. L., & Dooling, S. (2013). Flame and fortune in California: The material and political dimensions of vulnerability. *Global Environmental Change, 23*(6), 1410–1423.

Tear Fund (2008). Disaster risk reduction and the post 2012 framework. Bonn climate change talks. June 2–13, Bonn, Germany.

UNISDR. (2015). *Global assessment report. Making development sustainable: The future of disaster risk management* (311, pp. 307 p. + index). Genève: United Nations Office for Disaster Risk Reduction, online: https://www.unisdr.org/we/inform/publications/42809.

Walker, J., & Cooper, M. (2011). Genealogies of resilience: From systems ecology to the political economy of crisis adaptation. *Security Dialogue, 42*(2), 143–160.

Warner, J., & Van Buuren, A. (2011). Implementing room for the river: Narratives of success and failure in Kampen, the Netherlands. *International Review of Administrative Sciences, 77*(4), 779–801.

Weichselgartner, J., & Pigeon, P. (2015). The role of knowledge in disaster risk reduction. *International Journal of Disaster Risk Sciences, 6*(2), 107–116. https://doi.org/10.1007/s13753-015-0052-7.

White, G. F., Kates, R. W., & Burton, I. (2001). Knowing better and losing even more: The use of knowledge in hazard management. *Global Environmental Change Part B: Environmental Hazards, 3*, 81–92.

Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2004). *At risk* (2nd ed.). London: Routledge.