

Hybrid Disasters—Hybrid Knowledge

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Abstract Drawing from in-depth anthropological research in the San Francisco Bay Area, looking at a community of scientists, experts, and other risk-conscious residents who are preparing for the next large earthquake, this article argues for an understanding of resilience as an overarching heuristic concept with the potential to articulate multiple forms of knowledge into a collaborative approach, associating scientists, experts, and residents. Building on the corpus of literature coming from Science and Technology Studies (STS), Geography and risk Disaster Studies, this article discusses the emergence of the concept of resilience and its articulation with the existing literature. Following this exploration, I will look at the implication such concept in the re-definition of knowledge and the categories of expertise as observed during my field research in the Bay Area of San Francisco. I find that resilience can be a useful concept only if the rigid definitions that have separated academic disciplines, as well as the concepts of “science” and “experience,” are recomposed in favor of a more integrated approach taking into account the multiple, and emerging, dimensions of knowledge.

Keywords Disaster · Knowledge · Integration · Expertise

1 Introduction

Each disaster is unique. To prepare for the worst and increase the resilience of space “at risk,” researchers and experts have been documenting the multiples dimensions of disaster, documenting the complex and interdependent systems that a disaster can break down. These studies have focused both on the technico-socio-economic preconditions that tend to worsen the effects of disasters; but also—as the contributions of this book have shown—the cultural, political, philosophical and even

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metaphysical parameters that influence the conditions—and quality—of a particular response to a specific catastrophe.

In this chapter, I would like to discuss the potential and limits of resilience as an operative concept. Building on the idea that knowledge about disaster to come is necessarily incomplete, I will first give an overview of the emergence of the notion of resilience in the different fields of social science. Then, building on the field research conducted in the Bay Area of San Francisco between 2009 and 2013, I will show how experts and scientists of the Bay Area have learnt to use their empirical experience the earthquake risk and combine it with state of the art science production, creating de facto a corpus of knowledge that I will describe as “hybridized.”

2 A Brief Overview

Risk and disaster are hard to conceptualize and apprehend. As Oliver-Smith [1] writes:

Disasters are both socially constructed and experienced differently by different groups and individuals, generating multiple interpretations of an event process. A single disaster can fragment into different and conflicting sets of circumstances and interpretations according to the experience and identity of those affected. Disasters force researchers to confront the many and shifting faces of socially imagined realities. Disasters disclose in their unfolding the linkages and interpenetrations of natural forces or agents (pp. 25–26).

Recent major disasters, including a great number of earthquakes, have not only deeply transformed the actual space they impacted but also the world around them.¹ They forced us to face the human capacity to deal with, and to respond to, such events. As French geographer Michel Lussault [2] observed in the aftermath of the 2004 Indian Ocean tsunami, when engaged with destructive events, thinking becomes complicated by the influx of overwhelming information that seems incompatible with science’s need for impartiality and objectivity. He writes:

Soon, emotion facing what appeared as incomparable tragedies became global. [...] The extension at the scale of the globe of the rumors of the disaster came together with the diffusion of a spectacular dramaturgy associating narratives, pictures of professional and amateurs, more or less scientific description[s] of the tsunami and its consequences, science fiction discourses on the conceivable future replicas of such phenomena.² (My translation, [2])

¹Among others, they include Hurricane Katrina in 2005, the Haiti Earthquake in 2008, and the Christchurch Earthquake.

²My translation. In the original: “Rapidement, l’émotion face a ce qui apparut comme une tragédie incomparable devint mondiale (...) La dilatation à l’échelle du globe et l’écho de la catastrophe s’accompagna de la diffusion d’une dramaturgie spectaculaire, associant des récits, des images de professionnels et d’amateurs, des descriptions plus ou moins scientifiques du tsunami et de ses conséquences, des discours d’anticipation sur les future répliques envisageables d’un tel phénomène” [2].

The attention toward examining the multiple impacts of disasters, and the challenges they make visible for large metropolitan areas, is not recent. One of the most famous historical examples is the 1755 Lisbon earthquake, which had a considerable influence on the emergence of scientific knowledge. The Great Lisbon Earthquake, estimated at M.8.5 to 9.0 on the Richter scale, is credited with transforming the social, philosophical, and metaphysical paradigms of the time. Some have gone so far as to state that this moment marked the beginning of the era of European Enlightenment [3–9]. Discussing the importance of the Great Lisbon Earthquake for continental philosophy, Gilles Deleuze argues that the event had an intellectual and metaphysical impact equivalent to the one of Holocaust in the twentieth century:

It is very curious that in the eighteenth century, it is the Lisbon earthquake which assumes something like that, when across Europe people said: how is it still possible to maintain a certain optimism founded on God? You see, after Auschwitz raised the question: how is it possible to maintain a fading optimism about human reason. After the Lisbon earthquake, how is it possible to maintain the fading belief of rationality in divine origin?³ (My translation, [10]).

In the twenty-first century, large size earthquakes such as the 2011 *Tōhoku earthquake* still provoke shifts in our understanding of the world, forcing us to question the modernist categories inherited from the Enlightenment.

Today, experts and lay people alike have also come to question the horizon of a world without disaster, as well as the place that disasters can take in our everyday lives [11–15]. Acknowledging that the balance between dangers and safety precautions is constantly renegotiated in contemporary societies [16–19], researchers have also emphasized the role of expertise in the definition of such concepts [20, 21].⁴ Moving away from positivist definitions, these authors have engaged with larger questions posed by the complex relation between science, expertise and society [23–26]. Experts and scientists have—indeed—been often criticized for creating tensions within the democratic process [27] and not taking into account

³My translation. In the original, it reads: “Il est très curieux que au dix-huitième siècle, ce soit le tremblement de terre de Lisbonne qui assume quelque chose de cela, où toute l’Europe s’est dite: comment est-il encore possible de maintenir un certain optimisme fondé sur Dieu? Vous voyez, après Auschwitz retentit la question: comment est-il possible de maintenir le moindre optimisme sur ce qu’est la raison humaine? Après le tremblement de terre de Lisbonne, comment est-il possible de maintenir la moindre croyance en une rationalité d’origine divine?” [10].

⁴Wynne critiques are aimed mostly toward the reproduction of dichotomies, “which are key part of the problem of modernity: natural knowledge vs. ‘social’ knowledge, nature versus society, expert versus lay knowledge. It’s also reflects—and reinforces—a more basic lack of recognition of the cultural/hermeneutic of scientific knowledge itself, as well as of social interactions and cognitive construction generally. [...] I also thus problematize their uncritical conception of science and knowledge per se. It is important to distinguish here between their recognition of the (in recent years only) contested nature of scientific knowledge, and their uncritical reproduction of realist concept of scientific knowledge. This realist epistemology also, I argue, gives rise to an unduly one dimensional understanding of the underlying dynamics of the nature of ‘risk’ in the risk society” [22].

local knowledge [22]. But they have also been praised when they base their expertise on empirical knowledge [28] and when they coproduced knowledge along beyond disciplinary and scientific boundaries [29]. In fact, authors have noted, in many recent disasters, experts have been the beneficiaries of their own expertise [30–32].

The difficulty to deploy the entangled interactions and co-dependencies that composed the what is usually referred as “the” disaster, has been one of the many research programs tackled by researchers in Anthropology, Disaster Studies, and more recently, in Sciences and Technology Studies (STS).⁵ Social scientists have greatly improved the granular understanding of the risk and disaster life-cycle (before, during, after) insisting on the importance of culturally situated knowledge and exposing tensions between political and scientific expertise, cultural production and regimen of governance [34–38].

Studied through the frame of socially constituted and culturally meaningful practices, contemporary social sciences have enabled researchers to create an index of adaptation—or often mal-adaptation—between human and non-human facing disasters. These studies have tackled questions coming from very different disciplinary fields, from the physical, engineering, social, and political sciences to the humanities, using multiple methodological approaches anchored in diverse epistemologies within academia [17, 39], (Guarnieri, Sato, Pecaud, this issue), and beyond when engaging with the more operational level of technical expertise [40, 41], this volume) and policy-making [42, 43].

Questions related to the threat of potential disasters, which come together under the concept of “risk,” have become an extensive field of research, in which the seminal work of Beck [44] has been both celebrated and criticized [22, 45–48]. Following these trends, studies of risk that lacked empirical evidences—as it has been the case for Beck at the time of his first publication—were sharply criticized. As Latour [47] noted, “*like most sociologists, Beck suffers from anthropology blindness*” (p. 453). More specifically, Boudia and Jas [45] acknowledged that researchers reacted strongly to the publication of Beck’s book, documenting what seems to have been blind spots in the book, namely, citizen science, public participation in scientific research (PPSR), and the role of concerned individuals in shaping the definition of risk. Indeed, in more than 50 years of fieldwork [49–53],⁶ social scientists working on risk and disaster studies have shown that, when examined in detail, the conditions for the emergence of a risk and the characterization of a disaster, rather than being a homogeneous set of concepts, practices, and methods, have “*been continually fraught with internal tensions*” [55].

The Tōhoku Earthquake, Tsunami, and nuclear disaster of 2011 echoed this complexity [56, 57], (this volume) and has been broadly studied and commented

⁵STS can be defined as an “interdisciplinary field that examines the creation, development, and consequences of science and technology in their cultural, historical, and social contexts” [33].

⁶And this not mentioning the work done by United nation agencies in collaboration with social scientists see for instance Cabasse et al. [54].

upon, with interested parties asking questions about both the causes of the nuclear disaster and Japan’s capacity to recover from such a large catastrophe [58–63]. Reflecting on the consequences of a disaster—death, destruction, the challenges of recovery [60, 64] and the long lasting-trauma [65–67]; resilience studies forces us to revisit our understanding of the events, focusing on the relationships between individual and collective experience and complex scientific, political and engineering systems. The possibilities of interactions, if clearly defined, could reconnect with previous effort to conceptualize risk and disasters multi-dimensionally.

3 Thinking with Resilience

For almost a decade now, researchers have noted that: “Like vulnerability, multiple definitions of resilience exist within the literature, with no broadly accepted single definition...While numerous research efforts have assessed various dimensions of community resilience, challenges remain in the development of consistent factors or standard metrics that can be used to evaluate the disaster resilience of communities” [68].

Building on the research of “vulnerability”, which has tended to emphasize the subject as an agent, and his specific capacity or lack thereof, to adapt or adjust to a identified risk; resilience studies have favored a more systematic approach [69–71]. Using a specific case study located in the Sekhukhune District, Limpopo province of South Africa, Miller and al. have made explicit the divergences in the modes of engagement between the two concepts pointing the nature of this paradigmatic change:

In the vulnerability study, the aim was to understand how different stakeholders view their vulnerability to support decision-making at the village and municipal scales in Sekhukhune District. [...] In the resilience study, the aim was to establish an overall picture of system function, including qualitative system dynamics and vulnerability analysis, in the Sand river sub-catchment using resilience theory. [...] This study made explicit the linkages between the social and ecological system on the one hand, and the time scales at which certain drivers proved more important than others. The vulnerability approach placed more emphasis on agency and on the identification of hooks for responding to adaptation and development challenges [72].

Miller et al. are insisting on the divergence of “analytical tools, scales, and indicators of interest” [72]. But these divergences remain unclear about the political implications and controversies that arise when considering both the unit and the scale of analysis (a system, an individual?) and the moral and political dimension of the distinction as pointed by Reghezza-Zitt et al.:

The recent shift from vulnerability to resilience gives a glimpse of a radical change in the approach of international agencies to disaster management. On one side, a social vulnerability, mainly suffered by the poorest populations but that can be anticipated and reduced by various aids relying on solidarity and states’ participation. On the other, a desired resilience that is only validated long after the crisis and that sanctions adaptation at an individual level [73].

Following this argument, orientation of these conceptual investigations (resilience or vulnerability) should not be oblivious of political analysis which might help understand why and how, “environmental risk in the city is interpreted as an outcome of the political interests and struggles over power that shapes the urban environment and society” [74]. As Comfort et al. recall:

Some cities do better in the face of disaster than others. It is tempting to describe apparent success in terms of resilience and apparent failure in terms of a shopping list of explanatory variables. Resilience then becomes the synonym for survival and the prescribed antidote for administrative shortcomings. This is too simple (...) Far from a fix-it-and-forget-it approach, resilience is the outcome of a long-term process, enduring resilience is a balancing act between risk and resources, between vulnerabilities and escalating or unmanageable risk [75]: 272–273.

In 2009, the United Nations Office for Disaster Risk Reduction (UNISDR) have tried to unify these array of definitions, proposing the following synthesis: “The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions” [76].⁷ Trying to account for the multiplicity of situations in which resilience could emerge, UNISDR definition was building years of cases studies and an extensive body of literature and modelization, both empirical and theoretical, that had seen a succession of conceptual apparatus trying to account for the complexity of the phenomenon to be both described and tackled. This heuristic dimension was confirmed in 2014 when the National Science Foundation (NSF) announced that 50 researchers had been awarded a total of 17 million dollars [77] to “investigate questions related to vulnerability, risk and resilience in the face of various hazards as well as the everyday degradation that infrastructures face.”

Indeed, and perhaps because of this polysemic epistemology^{8,9} the concept of resilience seems to have been successful in fostering discussions between scientists

⁷During first conference in 2005 in Kobe Japan was adopted The Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters which contributed to the diffusion of the concepts of resilience define as “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions” [76].

⁸“There is no universal definition of the concept of resilience that can be applied to all domains. That said, the English term resilience, itself derived from the Latin verb *resilire* (to bounce), is made up of *re* (again) and *salire* (rise), which implies a retroactive effect [10]. While in the 1970s the term was associated with the ability to absorb and overcome the effects of significant, unexpected and brutal disruption to ecological systems, hybrid definitions have since emerged in many disciplines including geography, psychology, sociology, organizational sciences, ergo-psychology, etc. Within this smorgasbord of definitions, two fundamental ideas prevail: community and the process.” [43]: 3 this volume.

⁹Alexander [78] noted: “In theory, the term can be applied to any phenomenon that involves shocks to a system, whether it be physical or social, and whether the shock involve disasters or merely a hard knock in the literal or figurative sense” (p. 2713).

and practitioners from various disciplinary background. Since then, the concept has been largely adopted, “as much with scientists as with the administrators and international authorities in charge of preventing disasters” [73]. But, as pointed by Reghezza-Zitt, for social scientists working on risk and disasters, resilience is the latest iteration—and maybe not the least problematic—of a long list of overarching concepts.

4 Knowledge, Risk, and Building Resilience in the Bay Area

In the next section I will explore how experts, scientists and concerned residents of the Bay Area of San Francisco have collectively—and for decades—patiently built a awareness of risk that, they hope, will suffice to make the place they live and work in, resilient. Looking at the history of earthquake science, historian Deborah Coen [4] recalls that, in the nineteenth century, the “scientific description of an earthquake was built of stories—stories from as many people, in as many different situations, as possible” (p. 3). To define earthquakes, physicists and seismologists used their own perceptions of the event (e.g., “How did the earthquake feel?”) and their senses of observation (e.g., “What did it produce?”). They also used as many indirect sources as they could locate, including accounts from magazines and newspapers, testimonies of other observers, and, when available, measurements from scientific equipment. Yet, in seismology, like in many others scientific domains, progress of research over the last century has favored the movement from subjective accounts to instrument-produced data, allowing for the development of predictive models and probabilistic conceptions of earthquake risk. In the process, earthquakes have become more abstract objects of science, defined mainly by complex mathematical operations and modeling. In such a context, it might be expected that scientists and experts working on earthquake risk grow more and more distant from residents’ experiences [26, 79]. In a “world at risk,” to borrow one of Ulrich Beck’s book titles [80], earthquakes might finally have become like any other ungrounded, immaterial threat. Yet, for the Bay Area community of experts and scientists, dedicated to the understanding and mitigation of earthquake risk, knowledge about the latter remained hybrid and grounded in experience. In fact, this diversity of perspectives is precisely what makes this endeavor scientific.

The specialists of earthquakes who are also residents of the active seismic zone of the San Francisco Bay Area frame earthquake risk both as an object of science and an object of experience, pursuing a tradition of knowledge making now considered “hybrid.” Just as it was for seismologists of the area throughout the past century, today seismologist, urban planers, disaster preparedness specialists consider earthquakes as phenomena that “cannot be comprehended exactly” [4] and need to be understood from different perspectives [81]. Therefore, for these experts, getting ready for “the Big One” is an active posture, encapsulating a large set of

practices that articulate past, present, and future knowledge at different geographical scales: how memories of past disasters resonate with risks of future ones, how expert knowledge emerges from past and distant experiences, and, finally, how invisible threats transform space, subjectivity, knowledge, and politics in the SF Bay Area. This event horizon—the next Big One—provides an important perspective on a set of operations that happen each and every day in this area, and which, from residential choices to seismic-mapping activities, from memorialization to projection, define and help bring the potential consequences of a major earthquake into existence—into visibility.

This ethnography is built on my own research in the Bay Area of San Francisco, where I have identified the network of scientists and experts who connect science with their own experience of living in a seismic place and help making the Bay Area resilient [82]. As discussed above, when it come to evaluating a risk or thinking about a disaster, “knowing” is a complex operation. In the academic context, it is often taken for granted that scientific and expert knowledge surpasses lay knowledge, and that risk would be better prevented if only residents could think more as scientists do. Here, I want to show that, in the Bay Area, scientists and experts have also learned to think as residents do; re-defining their hierarchical categories, comparing and discussing everyday risks to re-situate the earthquake threat in a time frame and context of an individual’s life span. As discussed by one respondent living in San Francisco, involved in risk prevention and the development of building codes,

With earthquakes, they’re so rare and extreme that to understand them, you have to think of them in the spectrum of everyday risks, monthly risks, and yearly risks. These all get compiled together and, most people, whether they articulate it or not, they’re aware of that difference. You rarely find people that dumb that they don’t understand risk in their daily life. [It] doesn’t mean they always make the informed decisions, but they have an innate understanding of the rarity of things.¹⁰

Further, as a one-time non-expert resident, but now an expert in the field, recalled, the risk of an earthquake is not, and never was, “a given.” Rather, it has been progressively instaurated¹¹ by research work, specific practices, and attention to the matter. She stated, “I’m from Massachusetts and New York State. When I moved here, it was the 1970s; [The idea of a major earthquake] wasn’t in anybody’s

¹⁰Respondent D.21, personal communication, 2011.

¹¹Toward a definition of instauration, Latour [83] writes: “Instauration and construction are clearly synonyms. But instauration has the distinct advantage of not dragging along all the metaphorical baggage of constructivism—which would in any case be an easy and almost automatic association given that an artwork is so obviously ‘constructed’ by the artist. To speak of ‘instauration’ is to prepare the mind to engage with the question of modality in quite the opposite way from constructivism. To say, for example, that a fact is ‘constructed’ is inevitably (and they paid me good money to know this) to designate the knowing subject as the origin of the vector, as in the image of God the potter. But the opposite move, of saying of a work of art that it results from an instauration, is to get oneself ready to see the potter as the one who welcomes, gathers, prepares, explores, and invents the form of the work, just as one discovers or ‘invents’ a treasure” (p. 10).

awareness.”¹² This ongoing construction of earthquake risk was also not a one-way street; instead, it has been a slow elaboration of the capacities needed to understand both earth science and resident behavior, and many things in-between, such as the legacy of past and distant disasters, as well as cultural, philosophical, and meta-physical questions, often viewed in a reflective manner. In this context, experts and scientists have learned not only how to be rational subjects but also beneficiaries of their own expertise, specifically aware of the inherent tensions between forms of knowledge. In this process, scientists and experts have learned how to deal with, and even respect, residents’ understandings and practices.

Moving away from the easily-taken-for-granted discourse regarding the lack of preparation and the irrationality of the residents¹³ [84, 85], and also taking their distance with infructuous attempts to detach irrational thinking from idealistic, “pure” scientific knowledge, these experts have accepted that several “frames can be considered rational yet lead to radically different solutions” [86], p. 35). Taking this perspective spurs large possibilities, as this expert explained: “We need to define what is rational by what people do, rather than decide what’s rational and say that they’re not being rational. They *are* the definition of rational, and therefore we have to rethink what rational is” (emphasis added).¹⁴ This new perspective also changes preconceived narratives about people’s relations to risk,¹⁵ and in a broader sense, experts and scientists understandings of individual and collective dynamics and social phenomena. As one respondent who has worked in the field of hazards mitigation for 30 years recalled, the process of defining priorities for earthquake preparedness is often full of surprises.¹⁶ Taking the time to listen to the people they

¹²Respondent J.12, personal communication, 2011.

¹³As one, a structural engineer by training, summarized, “If it does not make sense for the people to retrofit their home, then it does not make sense by scaring them into doing it.” This thought is echoed as a common Bay Area sentiment.

¹⁴Respondent D.21, personal communication, 2011.

¹⁵Here, I mean “risk” in the literal sense. See, for instance, Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming [87].

¹⁶As one respondent stated: “We did a mail survey of people in the mid-1990s. It was intended to find out why people would choose do structural retrofit in their homes, and as part of that, we wanted to see the correlation with whether or not people have done the Red Cross kind of things, like food, water, and first aid. And it turned out—as a side-line, because we also asked their age and income—that the more educated you are, the less likely it was that you’re going to have food, water, [and] first-aid training; and the less likely it was that you would have made the structural changes to retrofit your house, regardless of income! [Laughs] And we thought, ‘Okay ... somehow, when people get a lot of education, they tend to have more blind faith that the utility companies are going to come through and they’re going to have food and water. And [they think] they don’t need to do this, because they know that their house is going to fall on the ground and therefore they’re going to fix it. Whereas the other group, which was less well-educated, was convinced that it was going back to that basic survival training.’ We were trying to hypothesize why this was going on, the basic survival training that they knew: that food and water were important on a day-to-day basis because they’re having to deal with it weekly, as they did their budgeting. And therefore: ‘I need to make sure that I have set aside a little extra so that I will have food and water in case of any emergency, not just a disaster’” (Respondent J.8, personal communication, 2011).

serve (the residents) and—more important maybe—accepting to be challenged, Bay Area experts have reframed their hypotheses and methods. Even more, building on their own experiences as residents, they redefine the meaning of “normal,” which for those living outside of major earthquake areas is often seen as a world without hazards. Understanding that earthquake risk can overlap in situations that were previously thought to be unconnected—like science and personal experience—they framed the contours of a situated, acceptable, but still moving norm of what it means to “live with earthquakes,” which never seems to reach a perfect and definitive conclusion.

Instauring the risk of an earthquake is a mental exercise (who can really say that he is prepared for a Tsunami or a large earthquake?) that allows experts to improve their knowledge about residential practices in a space of risk. It also allows for the residents’ capacities to define—specific and personal—knowledge of the danger that they are dealing with. This never-ending work in progress is continually renegotiated between residents and experts, moving the cursor of risk acceptability. In this process, many things are taken into account and all of the micro as well as macro events re-defined the spectrum of the earthquake risk and the condition of resilience: when a disaster at the scale of the Tōhoku earthquake, tsunami, and nuclear disaster of 2011 hit, but also when a building construction is planned, a child is born, a new scientific discovery is unearthed, a new law is voted upon, or the time comes to choose a new house. Experts and scientists of the SF Bay Area maintain the memories of and knowledge about earthquakes, helping to ensure that the rest of us never forget this invisible presence.

The co-construction of the risk is not the implementation of zero safety risk—for really, how could that be?—but the renegotiation of what is an acceptable level of threat that people can afford and agree upon, knowing that what can be done might never be sufficient to cope with the extent of the damage and destruction. In many ways, the incapacity to think *of* the danger frames the limits of this tightrope-walk mental exercise. How, then, do experts and residents articulate the known and the unknown, and how does that articulation add another layer to the construction of earthquake risks? In this case, knowledge is supported by the capacity to imagine the unthinkable, and to expect and accept the consequences of a large-scale earthquake.

5 Conclusion

To make a place more resilient is to accept that the polysemy of the concept is both a strength and a weakness. A weakness because resilience cannot be declared, it has to be slowly co-constructed and instaured. A strength because it has the potential to allow each actor of a catastrophe to define the concept in their own words. To conclude I would argue that recognizing the hybridization of knowledge not only changes the definition of science and knowledge, but also allows for the subjectivity of experts, scientists, and residents and what should be taken into account, or listen

to when trying to evaluate the condition under which a specific place could be considered resilient. And because they pose complex problems, knowledge about disaster have become more fully integrated.¹⁷ As Gerson [88] states, this integration does require some adjustments in the ways scientists operate:

One of the most important effects of integration processes is their encouragement of new specialties that separate from their parent specialties and become organizationally independent to some degree while continuing to increase their degree of epistemic integration [...]. This segmentation process [...] is one of the most important ways in which new specialties form (p. 5).

Yet, in the face of such statements, the experts' open secret is that many preventive actions cannot be accomplished preemptively. In such cases, scientists have to recognize that their scientific knowledge and their capacity for action to prevent, and respond to, major damage is limited, and that a potential future disaster can go way beyond—or simply be very different from—anything for which they had planned. In this process, thinking about resilience could be a way to think the unthinkable, to be attentive to the “other,” and to provide a platform for discussion beyond traditional disciplinary boundaries as well as the long-held scientific/laity divides. and are the criteria that should facing and dealing with a disaster, redefining the figure of the concerned scientist into a knowing subject, grounded in her environment, circulating between the layers of knowledge that, prior, had been used to define the categories of the scientist, the expert, the lay person, or the amateur.

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¹⁷Gerson [88] writes: “Integration thus means more than simple juxtaposition of efforts in the same location, and more than relationships that consist solely of market relations. Rather, it includes coordinated efforts to pose and solve new research problems that can redefine specialty boundaries. Because of its cooperative and coordinated nature, integration contrasts with the division of labor into independent lines of effort and the standardization of interfaces among line of work” (p. 516).

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