A Memory for a Better Resilience to Contemporary Risks

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Introduction

For historians, addressing the question of risk and resilience to past natural hazards definitely presents a challenge, because the use of the word “resilience” and “risk”, has emerged only in recent years. The term “risk” must be understood in the sense of a measure of the dangerous situation which results from the confrontation of the hazard and from the receptors (society). As a consequence, the notion of “hazard” will be retained here only in its most common meaning, that is an event defined by its intensity (or severity), a spatial and temporal occurrence. Nevertheless, to study the risk, it is advisable to understand the hazard. Originally from physics and psychology, the word “resilience” refers in this text to the ability of societies, considered as settlement systems, to maintain their fundamental structures in the event of disruption. Concretely, resilience aims to reduce mortality and economic losses, by means such as the use of external assistance to these local societies in the event of a potentially catastrophic event. Yet, in a fairly systematic way, the disasters of the last decades have often been presented by the media and national governments as exceptional events and therefore more or less unpredictable. This was the case for example for the Xynthia storm in France in 2010 or the Fukushima catastrophe in 2011 which in fact both had historical antecedents.

Risk and resilience are therefore intimately linked to the occurrence of the extreme event. Indeed, without victims and damage, there is no “social signature” and therefore no disaster. Thus, a major natural hazard (earthquake, flood, etc.), if it occurred in a totally depopulated region would not be a disaster. Because etymologically the “catastrophe” comes from the Greek word *Katastrophê*, literally a positive or negative upheaval for human beings. This etymological approach is a good reminder of the human dimension of catastrophes. This brutal and rapid phenomenon therefore marks a break and in fact leads to a modification of the settlement system concerned, to a new system that can paradoxically give birth to a more relevant and sustainable model in terms of reduction of the vulnerability (Garnier, 2017b).

Paradoxically, it is by looking in depth through archives at the analysis of disasters impacts on societies (risks and vulnerability) and their mechanics that historians discover indirectly the responses formulated by our predecessors that we could consider as the basis for adaptation strategies today. As Virginia Garcia-Acosta (2017) explains, the complex and multifaceted relationship between nature and culture has fostered the creation and transmission of knowledge to reduce the risk exposure of ancient societies. Nevertheless, this relation can only be understood if it is studied in the *'longue durée'*, in accordance with the recommendations of Fernand Braudel (1958) and Emmanuel Le Roy Ladurie (1972). Historians are thus interested in the forms taken by these adaptation

measures to reduce the vulnerability of ecosystems and communities exposed to hazards. While adapting to current natural hazards is often confined to their strictly economic, technological and physical aspects, the historical perspective gives greater focus to those aspects more easily accessible to our contemporaries, namely the cultural (risk perception, community relations, etc.), social (burden of inequalities, organisation of society, etc.), geographical (more exposed areas, fragility of environments, etc.) and politico-institutional (governance, standards and regulations, etc.) dimensions. Without these, it is very difficult to see how a society should react to an extreme event and how it should attempt (or not) to predict future crises by designing measures derived directly from past experience.

This paper provides an overview of the potentialities offered by a historical approach by addressing its scientific and societal issues as well as its opportunities at the scale of different continents and cultural areas. We then show the major role played by traditional societies and indigenous peoples in preserving and transmitting a culture of risk (Skertchly et al., 1999) which today is threatened by an unprecedented memory break resulting from the process of globalization as did Hoffman et al (2002) in the prospect of the cultural-anthropological conceptual framework. Finally, we present two concrete examples of projects aiming to use historical lessons learned to reduce the vulnerability of local communities.

1. The challenges of memory in terms of risk reduction

1.1 A better knowledge of vulnerability trajectories

Over time, these episodes are integrated into the history of the territories and societies retain their memory. This knowledge of past events is then decisive for the setting up of strategies to protect local exposed communities from the consequences of certain phenomena : the experience of the disaster conditions the management of the risk. At first, a society is aware that a hazard can occur on its territory and affect it. Then to a second degree, this object becomes a threat, a social concern. Lastly, institutions intervene and produce knowledge on this subject in order to implement management methods.

The study of vulnerability trajectories supposes to consider the historical dimension of societies, that is, the fundamental values on which they were built and their evolution up to today. This temporal dimension is however most often neglected, for lack of knowledge about how to fully integrate it. Nevertheless, only a holistic and dynamic view of vulnerability to natural hazards can help to inform, on an empirical basis, the vulnerability to current change. As we have already said, today's measures of vulnerability are thus doubly biased: first, because

they consider only economic aspects, secondly because they ultimately only apprehend vulnerability that at a time T (2050, 2100 ...), when in reality most vulnerabilities are in a process of evolution over a period of time (Magnan et al., 2012). The hypothesis that we formulate here is therefore that the vulnerability of territories to hazards is the result of an evolution of society as well as of the natural context. In line with the work of Blaikie et al. (1994), we thus go back to the "roots" of vulnerability on the scale of the last decades, or even centuries ago. This dynamic approach offers a twofold advantage: on the one hand, not to confine the analysis of vulnerability to a T-state (a simple snapshot) but to place it in an evolution (the notion of "vulnerability trajectories"); on the other hand, by providing an understanding of long-term trends, the empirical bases for discussing future vulnerability, thus counteracting analyses that are too often speculative and ineffective to draw a line of continuity between the issues of today and those of tomorrow.

By showing the historical character of the risk and by explaining how populations tried to face extreme events, historical experience will complete the scientific results and will partially adress the social expectations of the debate on global change and anthropocene impact. Arising from the fear maintained or reactivated by the memory of past disasters, the perception of risk is thus fundamentally a social representation and as such, an abstract tool much better adapted than the word "hazard" in the reality of the material exploited by the historian. This reality emphasizes at once the existence of stakes which can be lost because of their "vulnerability" to and their exposure to the destructive phenomena that are the extreme events. More precisely, it is a question of studying extreme events in their historical context by exploiting and by analyzing the wealth of the historical documentation. The approach wishes to answer a major question posed by all of the scientific community, the decision-makers and managers as well as by public opinion: are we witnessing the emergence of worsening new risks which are at least partially of climatic origin or are our societies victims of an increasing vulnerability connected to the inexorable increase in human population and settlements. In this respect, the work of Abdur Rehman Cheema (2016) is exemplary. Through a historical approach since 1947, it shows how the absence of a flood risk management network has deprived Pakistan of an institutional structure capable of coping with this major risk and provides current decision-makers interesting lesson learned.

Contrary to the assertions of the media after a new disaster, historical data shows that risk has existed for a long time in the historical records and because of that it has given birth to original strategies of adaptation in the past.

1.2 The transmitters of memory : States, religions and social elits

Historical documentation provides a series of very varied archives, voluminous and geographically scattered (Brazdil et al., 2005 and Garnier, 2013). Several types of series will be studied.

We shall be interested firstly in the administrative archives. Because of their strategic interest (ports, fishing, trade, war) coasts were closely administered by public authorities in Europe and Asia. So, the municipal acts of the harbour cities supply large quantities of information on extreme events (storms, storm surges, erosion, tidal waves). From the 15th century, earlier in the Chinese case, the development of the administrations (British, Spanish and French Admiralties) and the trading companies (British, Dutch and French India Companies) considerably enriches the quality of historical data by supplying daily reports and taking into account new continents (Asia, America, Africa).

Because of its still primordial influence in the world, cultural legacies derived from beliefs systems (animism, shamanism, etc.) and institutional religions (Christianity, Islam, Buddhism) must be privileged in disaster prevention. Often up to the 18th century in Europe and nowadays in other parts of the world, extreme events were considered a demonstration of the God's wrath. That is why the ancient societies asked the Church for an intervention.

Because of this they provide abundant information for particularly long periods in the case of Buddhist monasteries (since the 9th century sometimes) then Christian (since the 12th century or so) and muslims chronicles as historical records of the Umayyad, Abbasid and Mameluk eras.

As shown in the World Heritage List as part of the Japanese Fujisan Cultural Site, Kawaguchiko Asama Shrine (Yamanashi Prefecture) was connected with volcanoes or volcanic eruptions. This type of Shinto Shrine in Japan is centered on the worship of *kami (i.e.* spirit or phenomena that are worshipped in the religion of Shinto). In the Edo period (1603-1868), pilgrimages to climb Mount Fuji increased in popularity and mandala (spiritual and ritual symbol in Buddhism) were made both as souvenirs, and to spread the cult of the volcano. At the same time, a religious confraternity system became extremely popular in the Kantò region using magico-religious practices with talismans to protect followers from the volcanic catastrophe. Nowadays, this original cult is still followed in Japan by sect Shintò organizations and it illustrates the preservation of the memory of volcanic risk among the faithful.

Thanks to the religious processions, the historian has relatively homogeneous series of disasters recorded by chinese monks, imams (Tunisia and Marocco) or catholic priests (North and South America, Europe). These

religious ceremonies allow the reconstruction of very long historic data series generally between 1000 AD and 1900 AD, sometimes even beyond in the case of Catalonia (Martin et al., 1995). The Roman Catholic Church ordered these qualified ceremonies of rogations (*rogativas*) in Spain or processions in Portugal and in France to avoid endangering the established order or the socioeconomic balance. In the case of the droughts, processions were organised *pro pluvia*, literally “for the rain”.

The instrumental data produced by the meteorological and scientific societies from 1750 will also systematically be inputted because they supply thermometric, barometric or wind information. It will be completed from the diaries which multiply from the 1700s in Europe and Asia. Their authors are generally traders, whalers, buddhist or Christian priests, monks or imams and finally scholars. They describe very exactly the extreme events (disasters with instrumental information) and their effects by indicating for example the limit reached by a wave in a harbour city. Certain authors provide an integrated approach to the drought by combining the visual observations (heights of water in the hydrological scales on bridges), the phénology (state of the vegetation, the fires), the prices on markets and even its social expression in the shape of scarcity, discrimination reactions, riots (Garnier et al., 2013).

We shall also study the newspapers which, after 1850, describe these events and took photos of the damaged zones. They also evoke the reactions of the public authorities as well as the debates aroused by these disasters.

Illustration 1. Landmarks or plaque commemorating disasters : 1) historical flood marking flood marking (1795 and 1764) at Cambridge, St. John's College, UK. 2) Catholic ex-voto in Paris for the flood of January 1910. 3 and 4) Photograph and plaque of East Temple Pagoda of Kunming (Yunnan, China) about the earthquake of 1833. Source : E. Garnier.

Besides the written archives, we shall also realize an inventory of all the elements of the cultural heritage and the memory evoking the risks and the vulnerabilities. It will thus involve field work to recognize the pictorial testimonies, the engravings or even the marks of flood or earthquakes. In japan, such an approach could be very relevant for the numerous Tsunamis stones as the stele of the village of Aneyoshi (near Fukushima) which states “In memory of the great tsunamis of 1896 and 1933 (…) remember these disasters and never build your house on this side”. It will also serve to collect oral testimonies on territories at risk or on the contrary on those which were considered as refuges for the inhabitants. This last task is particularly urgent as witnesses, because of their age, will disappear over the coming years.

2. The role of indigenous peoples and traditional communities

2.1 Lessons learned from Yunnan minorities

Paradoxically, while many “primary” Chinese archives, in other words, written at the time of historical catastrophes, have mostly disappeared because of the Cultural Revolution (1966-1976), the archives produced by French missionaries established in the country since the 16th century (Eastern China) make it possible to reconstruct very long data series of historical hazards such as tsunamis, earthquakes, floods or droughts. The French Catholic priests had very bureaucratic practices and thus, almost daily recorded the events that occurred in their missions. Among these events, extremes are frequent and very well described because the religious orders, often Jesuits or priests of *Foreign Missions of Paris*, had been trained in the reasoning and scientific methods of their time (Garnier, 2017d). That is why, besides physical observations concerning the impact of these disasters, they recorded precise data using thermometers, barometers or even tide gauges.

In Yunnan, more exactly in the Upper Mekong Valley, French catholic priest settled from de 1840s, converting people belonging mostly to local Tibetans and Lizu communities called nowdays “minorities” by the Chinese government. A Bathang French priest described very accurately the course and effects of an earthquake that affected the entire Himalayan chain in June 1857. His report indicates the exact time, the duration of the shock, the damage to the dwellings (cracks, collapsing walls, etc.), as well as the number of aftershocks that followed the disaster. Better still, he uses the network of Indian and Chinese Catholic missions to collect information on a regional scale. At a time when seismographs are very rare and not very accurate (especially in this part of the world), his precisions make it possible to estimate at least in a relative way the intensity of the earthquake by comparing the historical descriptions with the European Macroseismic Scale in particular.

In constant contact with these mountain dwellers, the French religious orders have passed on in their archives the knowledge accumulated for centuries in terms of adaptation to natural hazards, which were very numerous in this valley. Faced with climate variability and extreme events, local people built landscapes adapted to risks of floods, landslides and aridity. Indeed, the reports of the missionaries evokes regular and severe droughts which cause bad harvests or/and major forest fires. The highest parts of the slopes were covered with diverse and irregular forests in which the peasants cut down only the trees they chose according to their needs in order to avoid creating open areas that would have favored soil degradation, runoff and landslides. In the lower part of the slope, they had built an effective agricultural system. Its most important component was the terrace system used for cultivating crops. In danger of disappearing since the 1980s owing to the rural exodus, these terraces prevented the

rapid flow of rainwater or the scarcity of water during drought season. The photographs of the time also reveal the existence of hedges that delineated these terraces and fields in such a way that the crops were protected against the most extreme events (avalanche, landslide in particular). This bocage system also provided the villagers with firewood and building houses.

At the bottom of the slope, the village or small town developed on a generally artificial plateau, which was drained via canals or channels to facilitate the evacuation of rainwater. Finally, new terraces avoided the too rapid runoff of water to reuse it on the agricultural level and slow the rise of the river's waters. Moreover, in order to slow down this process, the approaches to the river were generally uninhabited and developed as wetlands that accommodated livestock.

Illustration 2 : **managed landscape in the Salween Valley in the 1900s. The photo shows clear distinction between the irregular forest, cultivated terraces and wetlands used as protection against floods. Photography of the Missions étrangères de Paris.** Source. E. Garnier.

More interesting in terms of social vulnerability reduction, the missionaries indicate in their daily reports that they benefit of the natives an information handover of the risk culture when they arrive on the spot. Thus, they are warned of meteorological phenomena such as heavy rains, melting snow or earthquakes regularly generate mudslides, which they literally call the “walking dragon” or “flood dragon walking”, landslides or flash floods. In order for them to be able to identify them before the disaster, they teach them to recognize the warning signs such as the drying up of rivers, the decrease of their flow or on the contrary their increase, the observation of debris from upstream of the valley and, finally, the deafening noise from upstream or felt during the earthquake. In terms of

resilience, the natives recommend French priests to observe the sky and the rain, not to block the canals, to avoid staying too long in the valley floor during the rainy season. And if it is too late, they advise them to run to the high slopes of the valley away from the flow of debris.

Today, this exceptional lesson learned has been fully put to good use and publicized by the Chinese authorities in Yunnan Province. Information posters have been installed in recent years in the center of the villages where the French missionaries lived until the 1950s.

Illustration 3. Poster informing villagers about landslide prevention in the Cizhong area in the Upper Mekong Valley (Yunnan province, China). Source. E. Garnier, April 2017.

As we can read, this is an extremely educational propaganda poster dedicated to the prevention of geological disasters. In the form of simple drawings and short texts, it strongly recalls the advice given a century earlier by local minorities to French missionaries. It essentially presents the risk of mudslide by recalling the meteorological factors that cause them (rain, snowmelt, collapse of a dam) and describes its manifestations. As in the 19th century, the poster speaks of “walking dragon” and “walking dragon flood” to designate the mudslide. However, it is updated and completed in relation to the current context. For example, it describes damage to hydraulic and hydroelectric infrastructures, mines, and the many road construction projects. The list of warning signs is essentially the same as in the past, as well as the precautionary measures. Nevertheless, the text emphasizes the architecture and the “ecological environment of the valley” and the transmission of information quickly via social networks (WeChat in particular). The formation of a mudslide in four stages of cracking, creep, slip and

stabilization is also much better described. In order to be as educational as possible for literate adults and potentially illiterate children, the drawing associated with the text describes the cracks on the slopes, the foot of the curved slope, the deformation of the buildings on the slope, the water changes in wells and springs. It also recommends rudimentary but effective methods to observe and analyze the phenomenon such as the method of the nail, the buried pile, etc. Finally, the poster provides emergency advice such as the rapid abandonment of homes and escape from danger zones and promotes prevention in architecture. The inhabitants must choose a site outside the already collapsed ravines and places previously hit by landslides. They are forbidden to dig on slopes to collect materials or accumulate stones and earth in the most vulnerable places so as not to aggravate the disaster.

2.2 Tsunami risk culture and acculturation in Kanak communities

The last deadly tsunami that struck New Caledonia took place in March 1875 (Louat, 1988). This archipelago is now a special collectivity of France in the southwest Pacific Ocean located at 1,210 km east of Australia and 20,000 km from Metropolitan France. Its mixed population is composed of natives belonging to the Kanak community, Europeans, Polynesians and people from Southeast Asia. During the disaster of 1875, the *Luengoni*, *Joj*, *Mu* and *Ahmelewedr* tribes suffered the worst damage : 25 dead, several dozen wounded and hundreds of homeless. It is therefore the most deadly seismic disaster known in these islands which are particularly vulnerable to tsunami risk because of their proximity to the subduction zone of the Australian plate responsible for the horizontal and vertical movements of the Vanuatu arc. The threat of tsunamis remains permanent since nearly twenty events of this type have been recorded in this territory since 1875. Unfortunately, because of their very low impact, the authorities and populations have gradually neglected the permanence of this risk in the development of the islands. As a result, vulnerability has increased considerably in more than a century, and it was only in 2004, in the aftermath of the devastating December 26 tsunami that hit all of South Asia, that French policy makers became aware of this risk. This example illustrates perfectly what we explained previously about the etymology of the word “catastrophe”. For lack of hazard, its memory fades but its occurrence causes a disruption and, in some cases, a change of model that can be positive. This was the case in these French territories which became aware of a threat and which had been neglected by scientists and local and national politicians. Nevertheless, the investigations and reports of the Parliament on this risk were led by engineers and parliamentarians. This is why these works do not take into account (or very slightly) the notions of vulnerability and resilience of local societies.

Indeed, the French state then the government of New Caledonia, as very often also in Metropolitan France, have focused their strategy on a structural response to the hazard. It is therefore characterized by the creation of a network of automatic alerting populations (sirens), essentially technical solutions and especially new regulations inspired by metropolitan regulations often inadequate to the legal status of customary lands Kanak and applied (as in metropolitan France) without coordination with the inhabitants. In short, these measures contribute to disempower the populations exposed to the risks because they feel reassured by these governmental measures which they do not understand because they are too complex. However, a recent academic work based on the study of New Caledonian archives and field works analyzes the evolution of adaptation choices over the last 140 years and provides new insights into the loss of risk culture in Kanak communities (Le Duff et al., 2016). In particular, it identifies as a major factor of vulnerability the socio-spatial organization of the tribes that has undergone spatial upheavals under the influence of the Protestant religion to which the majority of Kanaks converted at the end of the 19th century. On the island of Lifou, religion became progressively central to the native society with the arrival of Protestant catechists from Aitutaki (Cook Islands) in 1842. Before the conversion to Protestantism, Kanak society was organized around small family hamlets whose location depended on access to fresh water and was not truly sedentary. Moreover, the identity of each group was built around the historical-mythical routes used by the ancestors. The victory of Protestantism profoundly changed this organization by gathering around the new churches and pastoral schools families and clans that could get fresh water on the new christian spots thanks to tanks built by pastors and French colonial authorities. That is why when the tsunami occurred in 1875, the populations of southern Lifou were concentrated on the coast and therefore heavily exposed. The disaster also revealed differential exposure to risk, depending on social groups, age and gender. Unlike men who hunt and / or fish, women, children and old people spend more time at home, so more time in exposed areas. Other aggravating factors are the ways in which knowledge is disseminated, particularly knowledge of coastal risk culture, which excludes women and children. Finally, this traditional knowledge was systematically targeted by pastors and their catechists because of their heterodox characteristic in relation to Christian dogmas. All conditions were thus met to facilitate the rapid disappearance of this knowledge which was transmitted orally.

Once again, a look at the historical documentation proves the existence of a solid memory of tsunamis among the inhabitants of this part of the Pacific Ocean. Protestant pastors give many concordant testimonies. In New Caledonia, the Kanaks refer to the tsunami as "*Gejë madra en drehu*" and "*Ngeni hna en nengone*", literally the "red wave (blood)", in other words the deadly wave. In Anatom, Vanuatu Island, pastors state that the inhabitants

still preserved in mind, by oral tradition exclusively, the memory of a tsunami that occurred 50 to 100 years earlier ! Here is the translation from Pastor Inglis (1875) :

"The "naturals" (i.e., indigenous people) say that their fathers told them that once an earthquake struck the rocks from the mountains and rolled them into the valleys and the sea rose and covered the lowlands; but of all those who live today, none have seen these earthquakes (and tsunamis) ».

Protestant missionaries, without establishing the link between their Christian teaching and the remarks of the natives, explain that the inhabitants did not flee in the aftermath of the earthquake of 1875 and that they had gone back to sleep "after having thanked God for his protection". Thus, the massive adherence to Christianity and a very fundamentalist faith favored the abandonment of traditional knowledge by men, holders of this oral culture. This is why women and children were no longer trained about local natural hazards. All of them preferred to believe in a new divine power appraised superior and protective.

Nowadays, in the Loyautés Islands archipelago (Maré, Tiga, Lifou, Ouvéa islands), the coastline concentrates 40% of the resident population, 46% of the school pupils% and 80% of the tourist facilities. The strategy of the French State in recent years has been based on the installation of sirens and a technical network (Seismological NETwork or ORSNET) which reduces to 5 minutes the time between the detection and transmission of information to the local authorities which must then warn local communities that trigger sirens. That said, even if the sirens alerted before the wave arrived, populations concentrated on the coastline would probably not have time to evacuate the coast.

2.3 A Mediterranean society in the forefront of drought and flash flood risks

In numerous Mediterranean regions, water resources are exploited so intensively that it runs the risk of causing droughts, major water shortages or severe flash floods. In an uncertain climatic context, the situation could get worse again if an outbreak of droughts occurs, as is predicted by numerous climatic models. The report IPCC-SREX underlines the absence of transverse knowledge on this subject. There is a lack of hydrological data, of historical context and of knowledge regarding traditional practices, all of which could help consolidate or contradict the current climatic models. Besides the pressure exercised by the climate change, the transformations in the use of land constitute an aggravating factor for the Mediterranean environment and water resources. These changes in the use of land proceed from anthropogenic interventions engendered by agriculture, urbanization or

additionally by natural events such as fires for example (Sofios et al, 2008). The following contribution was part of the European Union FP 7 Drought R&SPI project led between 2011 and 2014 (http://www.eu-drought.org).

Whithin this study, a specific historical look concerned Syros Island (Garnier, 2015), situated in the Cyclades (Greece), located in the Aegean Sea 144 km south-east of Athens. Syros Island covers an area of 86 km^2 and had 21,507 inhabitants in 2011 divided between the rural parts and the two towns of Hermoupolis (capital of the island) and Ano Syros, a density of 260 inhabitants per km^2. To understand the traditional daily management of water, notarial records were studied for 19th and 20th centuries. Indeed, sales contracts, leases and wills reveal issues related to access to water in rural areas and in the old town of Ano Syros. These archives bring to life traditional hydraulic techniques used in the Cycladic islands for centuries, evoking village or family water systems today largely abandoned because of new agricultural practices, rural exodus and recent urbanization. Religious archives of the Catholic community located in the island from the 13th century have been very useful for studying the historical droughts and to try to assess their severity at a time when there was no instrumental data. Practiced in all Catholic countries, the "*pro pluvia*" procession (for rain) was an original ceremony practiced in Europe since the Middle Ages. Believers asked God, the Virgin Mary or their local saints for divine intervention in order for it to rain and the drought to cease.

Historical records are not sufficient to address the issue of water use in the past. In fact, they provide a knowledge captured at a given date, and agronomic, technical and cultural descriptions which are sometimes very difficult to interpret in the context of a diachronic approach. This is why an oral survey was conducted with individuals directly involved with the water problems in the island. A panel of 13 witnesses was chosen based on their age, their occupation or their influence in local communities (religious, community and political) as well as officials and local politicians.

In the face of current challenges, namely the economic crisis, the demographic development and access to water, the experience of history lends a clear legitimacy to future strategies of sustainable development. De facto, archives as well as the testimonies collected from old people highlight the traditional management of water and droughts compared with contemporary practices. In an article published in March, 1960 in a local newspaper about the water problem, the past role of *anavathmi*, the terrace system of cultivation used for centuries in the Cyclades is evoked. Already endangered because of the rural exodus, the newspaper praises their virtues by explaining that they prevent the fast flow of rainwater towards the sea thanks to the cultivation of vegetables, some barley and to the arboriculture (olive trees and fig trees mainly). Because of its mountainous character, particularly

the north part, and of its semiarid climate, the construction of terraces was imperative from antiquity to make best use of the low precipitation, maintain grounds and develop farming. The terraces still visible today are maintained by a retaining wall the construction of which requires the reorganization of the preexisting ground to the full height of the wall. Then, the farmer sets up the base of the wall and a heap of rubblestones to direct the drainage towards the interior of the wall. So, sediments carried by rainfall accumulate behind the walls of terraces laid out in a cascade formation.

While Syros has to face currently the return of a population chased away from continental Greece due to the economic crisis, the traditional savoir-faire regarding hydraulic techniques, regarding town and land settlement and of agronomy deserve to be taken into account by the European and Greek decision-makers in the perspective of a sustainable management of water.

Illustration 4. **Terraces of crops (*anavathmi*) in the North of Syros, 2013.** Source : E. Garnier.

Archives and chronicles of the 18th century show the existence of an agricultural system of original rotation of crops. It includes a part under the plow (*engheria*) and another one lying fallow (*pastra*). These lands sowed alternately were cultivated by means of the swing plow which enabled plowing in a crossed pattern to retain the humidity and the rains, the major part of which fall in October and in November. The land which was fallow for one year was not wasted because vegetables were sown there. More important still at this time of discussion on the adaptation of societies confronted with the water shortage in Africa and in the Mediterranean regions, the oral testimonies revealed the existence of plants called *anhydra*, in other words, plants which were not watered.

Produced for centuries in the Cyclades, these plants included melons, tomatoes and French beans which were cultivated on the cooler north-facing hillsides. To compensate for the absence of irrigation, farmers prepared

the ground by breaking it so that it is not too hard and so that the night humidity can penetrate. Endangered today because they are now only cultivated by elderly people, who still preserve seeds these plants produce on average 4 to 5 kilograms of vegetables and fruit a day for a surface cultivated of less than 5 acres (Garnier, 2015). As a paradoxical effect of the last economic crisis, terraces which had been largely abandoned over these last few decades and reconquered by bushes and shrubs, have now benefitted from the return of the native island inhabitants who had previously migrated to Athens. Unemployed and impoverished retired people have returned to the family farms to run them again after a long period of abandonment. Deprived of financial means, they try to reuse the traditional hydraulic techniques but the task turns out to be difficult because the knowledge has been lost sometimes irretrievably.

3. Integration of historic lesson learned into DRR strategies

3.1 "*Fluctuat nec mergitur*": Paris and the flood risk

"*Fluctuat nec mergitur*", in other words, "it floats but does not sink", such is the motto of the City of Paris which refers to the multisecular risk of flooding in the French capital. In June 2016, the Seine River flooded Paris at a time of the year considered by specialists as totally unusual. In the aftermath of the disaster, European climatologists claimed that such an event had occurred only twice in the Seine Valley for 500 years (Van Oldenborgh et al., 2016). Its impact was very serious on the activity of the city since it hosted the European football Championship as well as many tourists. On the financial side, it resulted in a cost of more than 1.4 billion euros. More than a year later, in January 2018 this time, the Seine again caused a flood in several regions including Paris. These periods of bad weather caused major damage, estimated between 150 and 200 millions euros according to the French Federation of Insurers. These two hydrological events remind us that the city of Paris has a very high level of vulnerability to the risk of flooding. However, in the event of a major flood like that of January 1910 during which the Seine reached the height of 8. 62 m, the impact would be 50 to 100 times greater if we include the material damage, economic disruption and evacuation of residents threatened by the river. Of the 463 km^2 exposed to flooding in the Paris region (Ile-de-France), more than 25% are dedicated to housing (830,000 inhabitants exposed), economic activities and transport infrastructure. However, in the event of a major flood, we expect even greater major disruptions due to the concentration of infrastructure (stations, international airports, motorways), political decision-making centers, and because of the burial in the ground of electrical and communication networks. In its 2014 report, the Organisation for Economic Co-operation and Development (OECD) estimates the direct damage

caused by the flood between 3 and 30 billions euros depending on the flood scenario and a decrease in GDP of 0.1 to 3% over 5 years.

Aware of this major risk for the country, the French government has been trying for decades to prepare for such a disaster. For the first time, it conducted a preparation exercise in March 2018 called *Sequana*. It planned for a much slower rise of the Seine (50 cm / day), a winter scenario directly inspired by the disaster of 1910 (frozen soils and sudden warming), with nevertheless a rise of the river, and in particular, it envisaged only the overflow of two tributaries (EU SEQUANA, 2016). In practice, many partners of the defense network participated only occasionally in the exercise as did many municipalities. Officially, *Sequana* would have made people aware of the risk of flooding, a rather dubious assertion if we observe their reactions during the subsequent floods in June 2016 and January 2018. The last two events revealed a sense of surprise and unpreparedness within disaster-stricken communities, particularly those in housing estates built in flood-prone areas over the last 30 years. As is often the case in France, *Sequana* primarily mobilized public actors (Prefecture of Police, firefighters, administrations, military), in accordance with the French welfare state model. More generally, the defense system in Paris and the Ile-de-France region is based on a very limited knowledge of historical disasters because of the choice by the engineers of the State to use the flood of January 1910 as the reference. Usually, the historical reference series used by the State concerns only winter floods and almost ignores the events that occurred between April and October. Thus, the floodmarks of Parisian floods referenced by the Ministry of Ecology (DRIEE) on its public websites does cover 79% the flood of 1910, but only 13% of other floods occured in the 19th century and only 3% for the period prior to 1800. Given that fact, we understand better the "surprise" caused by the flood of June 2016, especially because only one extreme of this type had occurred since 1900. This "break" of the memory could therefore have serious consequences if the entire prevention strategy of Paris is based on an event of the type of January 1910.

This is why the flood of June 2016 was described almost immediately as an “atypical” flood by elected officials and engineers. Indeed, a spring flood was in contradiction with the hydrological models of winter floods established by the engineers of the 19th century and which serve as a reference for the current managers of the Seine (Fujiki, 2017). However, one of the main uncertainties in terms of major flood is the question of the “evacuation policy” planned by the Préfecture de police, in other words the mass evacuation of the inhabitants of Paris (between 700,000 and 1,100.000 people). It plans a “self-evacuation” of residents with their own cars while the records show that in 1910 the streets were impassable, except with boats because of the overflow of sewers. Under these conditions, the evacuation with private cars seems difficult to imagine because they will probably be

drowned in the streets or in the underground garages. And even if the alert was launched before the rise of the river, so many cars would necessarily cause traffic jams that would paralyze traffic and therefore evacuation. Uncertainty results mainly from the knowledge of the hazard itself since the whole defense strategy elaborated for decades takes as a model a single event (January 1910) studied moreover only in its hydrological and non-sociological angle. However, in 1910 most of the transport infrastructure (metro stations, train stations) was unusable and a few riots broke out which had be repressed by the army. Little is known about the extent of the flooding caused by the rise of the phreatic table and the saturation of rain and wastewater networks, although they are very well documented in the archives. As a result, Paris' protection strategy suffers from a clear lack of historical knowledge.

A very recent historical study conducted for the Territorial Public Establishment Seine Grands Lacs (EPTB-SGL) delivers a much more robust series of floods since the beginning of the 16th century (Garnier, 2018). It records 81 floods between 1500 and 2018, while the official database of the Ministry of Ecology (http://bdhi.fr/appli/web/visualiseur) lists only 32 events (including 20 since 1910), or in other words 49 more !

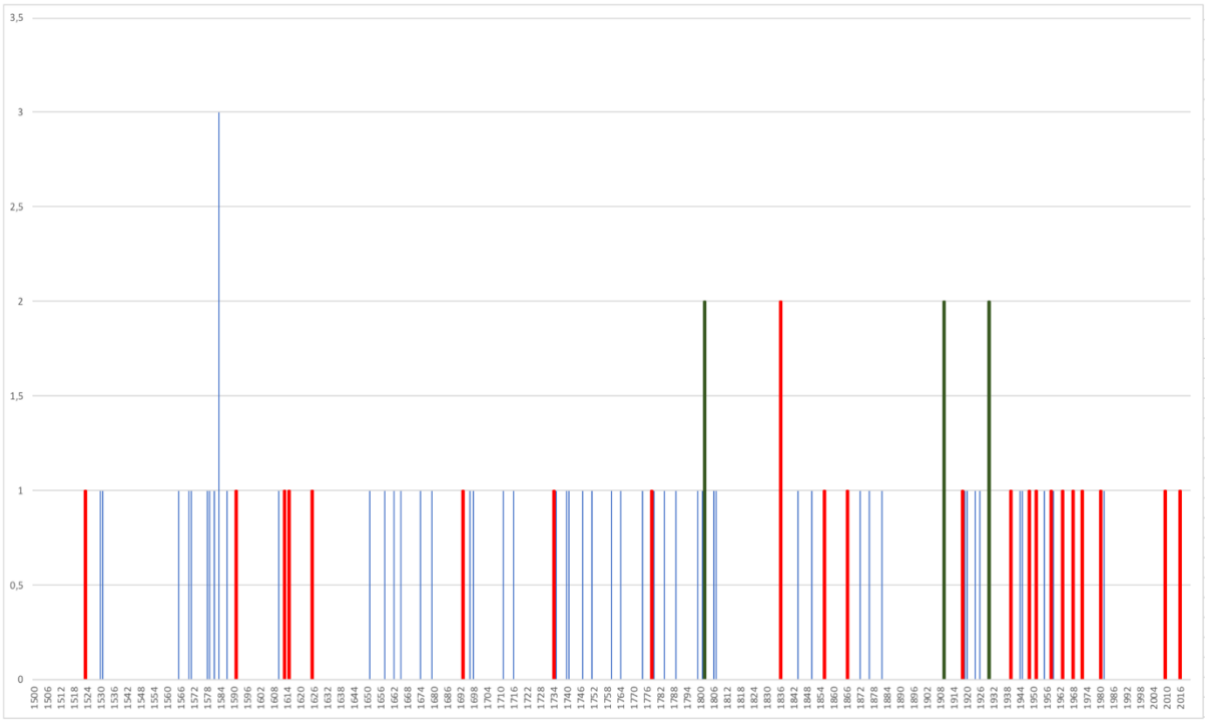

Figure 1 : number of floods in the Seine basin between 1500 and 2018. In red : floods in warm season (April-September). In blue : floods in cold season (October-March). In green : floods occurred during both periods of the year. Source : Garnier, 2018.

The graph shows a fairly uneven distribution of hydrographic extremes between the years 1500 and 2017 and the absence of a climate signal in the current context of climate change. Nevertheless, there is a higher

frequency of events in the second third of the 16th century and between the years 1940-1960. In contrast, the last third of the 20th century, does not undergo an increase of extremes. On the contrary, we can observe a relatively long period of remission of about twenty years between the years 1980 and 2000.

Research in the archives shows that more than 40% of the floods that occurred between 1500 and today occurred between April and September. Again, the historical database of the Ministry of Ecology records only 6 events of this type (June 1613, June 1697, May 1836, May-June 1856, September 1866 and July 2000), the in-depth study of primary archives lists 33, a notable difference of 27 floods not yet recorded by public managers. Such a result undoubtedly represents a major contribution for the managers and the Ministry of Ecology, in particular the General Directorate for Risk Prevention (DGPR).

Due to the lack of data on flows before 1830-1850, the return period calculations presented here correspond to the calculation method used by the Central Reinsurance Fund (CCR) in charge of compensation of natural hazards for the French State.

Table 1 : **return periods of floods (cold and warm periods) 1500-2000**

Century	**Return period (years)**
16th	6,6
17th	6,6
18th	5,9
19th	9
20th	5,5
16th-20th	**6,6**

Table 2 : **Periods of return of floods in cold period 1500-2000**

Century	**Return period (years)**
16th	8,3
17th	12,5

18th	7,8
19th	14,2
20th	16,6
16th-20th	**10,9**

Tableau 3 : **Periods of return of floods in warm period 1500-2000**

Century	**Return period (years)**
16th	33,3
17th	14,3
18th	25
19th	25
20th	8,3
16th-20th	**16,6**

This new historical series is therefore of strategic importance, both in terms of estimating return periods and seasonality of floods and of risk culture in a region where real estate speculation is very strong. The historical frequency of the spring and summer floods should probably be taken into account in the prospect of the future Olympic Games to be held in Paris in the summer of 2024. It must also challenge the political decision-maker when, despite the recent floods in June 2016 and January 2018, plans for a "return to the river" to install new recreational, commercial and artisanal areas along the banks of the Seine in Paris. Some municipalities in the Paris suburbs even plan to create river marinas despite the fact they have regularly suffered floods in recent times. Such infrastructure could therefore increase both the vulnerability of territories already exposed to flood risk and the cost of future disasters in case of a major flood.

3.2 Improving resilience by the memory of risk and landscapes : Boscastle (Cornwall, UK)

The village of Boscastle has for at least 150 years attracted significant tourist numbers. The lower village and harbour sits within an area of Outstanding Natural Beauty, a Conservation Area and the lower valley is largely in National Trust ownership.

On August 2004, two millions tonnes of water flowed through Boscastle, causing desvastating flooding in this coastal village. Swift action by local people and emergency services meant that no lives were lost. Helicopters rescued about 100 people from rooftops, cars and trees. The flash floods, caused by five hours of torrential rain, affected 100 homes and businesses on Boscastle – four properties were destroyed. 115 vehicles were swept away and roads, bridges, sewers and infrastructure badly damaged (Rowe, 2004).

Following this disaster the challenge was to reshape and enhance Lower Boscastle's flood protection, creating a safe environment that maintained the communit's sense of place and identity. The resulting clean-up operations, villages regeneration project and flood defence scheme required an effective partnership between a number of organisations which saw the completion of works in the summer of 2008. Working closely with Forrabury and Minster Parish Council were partners Cornwall County Council, Environment Agency, the National Trust, North Cornwall District and South West Water. Additional funding came from the Department for Environment, Food and Rural Affairs, Objective One Partnership for Cornwall & the Isles of Scilly and the South West Regional Development Agency. The flood alleviation strategy project aimed at building a new sensitive and heavily protected landscape and promoting a sustainable risk culture amongst the local community. The main car park access was improved and the parking area was moved away from the river edge incorporing the design of over land flow routes and vehicles escape routes, reducing the route of flooding and improving the riverside environment. This improved habitat and increased biodiversity potential through the use of native planting, meadow restoration and hedge replacement has been established on reinforced embankments beside new riverside footpaths. The project took into account the condition and value of physical elements that remained post flood in order to understand the damage caused and what items retained historical integrity. In this prospect, project team managers studied earlier character studies, photographic evidence, discussions with local people and historic map studies. Such an approach showed for example that the constrained river channel had been wider in places during the 19th century, and over time the channel had been in filled and riverside land had been built on to allow port activities to expand. In this way, and in order to tailor the engineering design options to the location, they could define how much change could be tolerated by the protected landscape. In conjunction with the engineering works, the developers and the

community of the inhabitants, closely associated with the post-catastrophic project, took care to integrate the memory of the catastrophe in a double perspective. The first, immediately noticeable for the visitor when he arrives at Boscastle is the landscape inscription of the extreme event in the urban fabric. Specifically, they installed several plaques commemorating the event and the reconstruction of a destroyed building or the water level of 16 August, 2004. They are situated in strategic places of the village in terms of touristic visits. We find them for example by the car park ticket office, in the entrance of the very popular 'museum of witchcraft', the main souvenir shop or still that of National Trust. All welcome annually a large number of visitors.

Illustration 4 : highly visible plaque commemorating the 2004 flood installed on the Cornish Rambler wall, a popular shop known for bringing a wide range of British Clothing and Footwear. Source : E. Garnier, 2014.

The second perspective concerned the memory which it was absolutely necessary to preserve and pass on, as well to the inhabitants as to the visitors. This is how the community also built a visitor centre where everybody can discover at the same time the disaster of 2004 and the historical reality of flash floods in Boscastle and in its region. Several posters and a video present the progress of the disaster of 2004 as well as the very numerous testimonies of archives. They tell and describe identical flash floods for 1827s, 1847, 1938, 1952, 1957 and 1958. The educational objective of these posters is obvious. It is a question of showing that the flash flood of 2004 was not a new event in history and that it will not most probably be the last one.

Account of the flood of October 28, 1827 presented by a poster of the visitor center :

One of the most awful days I ever experienced at Boscastle. It rained very heavily in the mornig & whilst we were in the Chapel increasingly so – when about the leave the whole street was filled with a body of water rolling down & carrying all materials with it – that devastation & ruin were its concomitants – by about 1 o'oclock the rain ceased

leaving the fine MacAdamised road in complete ruin from Polrunny to Dunn Street. At Bridge teams of Wagon Horses were saved with difficulty. Pigs also belonging to the Cottages were taken out of ye roofs of Houses. But thro the goodness of God and the East River (Valency) the waters were raised but little & our property preserved in safety – I would mark the finger of Divine providence & acknowledge his loving kindness.
(From the Journal of Thomas Pope Rosevear)

Finally, the community celebrate every year the anniversary of the disaster in the presence of the elected representatives, the pupils of schools and inhabitants with commemorative plaques. Rebecca David, manager of the visitor centre, summarized moreover perfectly this will to create a culture of the 'preservation' when she declared Boscastle has a lot of history, and the flood is just one part of it. We have just to keep it in mind'.

Thus, the village of Boscastle perfectly illustrates the etymological meaning of the word catastrophe among the ancient Greeks. On the spot, the disaster was overcome as an opportunity to restart the life of the community according to a dual model combining new components (engineering works) and a familiar landscape and cultural framework.

Conclusion

"Most of our troubles are still our work" (Jean-Jacques Rousseau, 1755)

This quotation of the French philosopher Rousseau on the earthquake of Lisbon on All Saints' Day 1755 remains inescapable in the contemporary reflection on vulnerability and Disaster Risk Reduction. Not only were his words written within the context of a marine flood, a tsunami caused by three successive shocks, but better still, they gave rise to one of the first public denunciations of the vulnerability of a littoral city. Extracted from his "*Lettre sur la Providence"*, the speech of the philosopher resulted in an extremely radical proposal because he proposed a limit on the size of coastal conurbations and calls upon a principle the paternity of which is often claimed by our modern societies : the precautionary principle (Garnier, 2017).

De facto, this study shows how forgetting past disasters has contributed to increasing the vulnerability of our modern societies and building for nearly a century what sociologist Ulrich Beck (1992) called "society of risk". Paradoxically, industrialization and the era of the engineer opposed "pre-modern" societies to so-called "modern" societies. In this way, ancestral knowledge and strategies have often been despised in favor of hard defense works

whose limits are now being measured after the disasters of 2010 (France), 2011 (Fukushima) or more recently in Laos (July 2018) and Italy (August 2018). On the other hand, a different model combining both engineering and local historical / cultural knowledge would probably be more sustainable and applicable. Instead of a “vertical” strategy (centralizing model) applied to vulnerable societies that often undergo planning decisions, the new model would instead incorporate all local knowledge (historical, religious, cultural) in terms of risk reduction. The latter would then become vectors of mediation between those who decide and those who live on the spot (Garnier, 2017 c).

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