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PART 1

Toward Unprecedented Risks?

1

Coastal Risks: Coastlines Always Under Pressure

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1.1. Introduction: environmental risks/natural risks

In a context of climate change and concentration of human activities on the coasts, the risks of coastal erosion and marine submersion are constantly increasing worldwide (Nicholls and Cazenave 2010; GIEC 2013). Thinking about these risks in relation to the Anthropocene means questioning the nature–society interactions that are at their origin. The coastal risks of erosion and submersion are the result of the encounter between intrinsically mobile coasts and static human constructions.

In the midst of the Anthropocene, where environmental concerns occupy a growing place in our societies, coastal risks are often considered (by the Ministry of the Environment, by the natural sciences) as environmental risks or challenges, in the same way as the erosion of biodiversity for example. However, this term is ambiguous, because it brings together very different problems in terms of the respective places of humans and nature. Is it a danger to the natural environment or a danger from the natural environment? It is conceivable that these are not the same thing, indeed that they are almost the opposite, and the distinction is essential when it comes to managing these risks. The ways of posing the problems, of proposing solutions and of arguing them are totally different: defending nature or defending against nature? Moreover, the terms used in management policies reflect this ambiguity. If the actions of “coastal protection” or “coastal defense” seem to be a consensus in our societies, for some they mean protecting the “wild” coasts against

excessive urbanization and associated pollution, and for others protecting the inhabitants and their property against attacks from the sea.

Basically, and more generally, the major difference between these two positions is the place of the human in the problem of “environmental” risks. Either (i) he is perceived as a disrupter, a waster of resources, putting humanity in danger by his excesses: then we are criticizing excessive and harmful development for the planet. It is our planet as our home that is at stake, and man who is the risk. Management then consists of regulating human actions to slow down the degradation caused to nature. Or (ii) it is man who is perceived as threatened by natural hazards (floods, volcanic eruptions, tsunamis, etc.). The man represents the stakes, when the human lives risk being lost and when the goods (houses, roads, networks, etc.) risk being destroyed. Management in this case is to try to control destructive natural forces to protect human stakes and prevent disasters (Pigeon *et al.* 2018). When it comes to risk, defining what is considered a hazard and what is considered a stake appears to be an essential prerequisite to any analysis.

However, the Anthropocene moment implies a paradigm shift that tends to take place in terms of risks related to nature. The vision of devastating nature finds less echo in the approach of scientists and societies (particularly the wealthy ones): nature is more and more presented as a stake to be defended against human destruction rather than a dangerous hazard. On the subject of coastal risks, this paradigm shift is particularly notable and places these risks in an ambiguous position. While they are considered as “environmental challenges” that place nature at stake in many research programs and political discourses, they are understood as “natural risks”, the danger of which is caused by nature, in most management measures, such as in the Natural Risk Prevention Plans in France (*Plans de prévention des risques naturels*, PPRN).

This distinction between nature and society may seem excessively dichotomous. Geography is precisely the discipline that studies the relations between these two theoretical entities through systemic approaches where all the elements are in interrelations within the ecumene (Berque 1996). In the field, everything communicates through porous boundaries, as evidenced by the well-known anthropization of many natural hazards (D’Ercole and Pigeon 1999). As far as coastal risks are concerned, if it is admitted that the hazards are attributable to natural dynamics (geomorphological and hydrodynamic processes generated by meteorological and marine forcing), it is also well known that these natural hazards are often aggravated by anthropogenic factors (sediment extraction, harbor structures, dikes, etc.). Furthermore, the distinction between natural and anthropogenic factors is made even more difficult by the influence of climate change

on coastal hazards, the human component of which is now demonstrated. It is therefore not easy to distinguish between natural and anthropogenic components in coastal hazards. However, two things are clear: the main stakes in this problem are human (human lives and built stakes), and in terms of management, the objective is to avoid damage to these stakes as much as possible. The coastal risks are therefore for us “natural risks”. This precision is essential to conduct a scientific analysis and even more so to draw lessons for society.

Section 1.2 presents the importance of coastal risks in the world during the 20th century and the links with climate change. Section 1.3 discusses the concept of systemic vulnerability of coastal territories and its application to the French coastline. Section 1.4 takes a reflective look at the challenges of action research and what the notion of the Anthropocene can contribute.

1.2. Desire for shores and climate change: the increase in coastal risks in the world in the 20th century

As with all so-called natural disasters, coastal hazards have taken on an unprecedented scale throughout the world in the 20th century. It is often difficult to identify them precisely in international statistics because they are partly classified as *floods* and *storms*. In France, they are also listed under landslides for erosion and cliff failures. Even if there is no worldwide data on coastal damage, their growth follows that of other natural disasters. As for any risk, the causes of the increase in damage are to be found in the intersection of hazards and stakes. While the former show a tendency to worsen, which is highly echoed by the media in a context of climate change, it is the latter that have multiplied most significantly.

1.2.1. Coastal hazards and climate change: the interweaving of several spatial and temporal scales

The strong storms, cyclones and hurricanes of the last decades and their consequences on the coasts on a global scale have led the media, and sometimes scientists, to emphasize the direct causal links that may exist between climate change and the current evolution of shorelines subject to erosion and submersion.

To understand this link, which is less obvious than it seems, it is necessary to put contemporary coastal geomorphological dynamics into perspective in the context of their evolution (Hénaff *et al.* 2013). They are part of processes acting on different intertwined temporal scales: the postglacial transgression at the origin of the establishment of the current coastlines, the historical evolutions of the shorelines and

the permanent dynamics of the coastal forms subjected to meteorological and marine phenomena.

First of all, the development of the present coasts is largely the result of geological time scale conditions and climatic fluctuations of the quaternary period. The last cold period and the marine transgression that followed it created massive accumulations that constitute our current beaches, pebble strips, coastal dunes and maritime marshes. These inherited sedimentary stocks are no longer massively fed today, but they are permanently reworked by an intense geomorphological dynamic.

Then, over a secular or multi-decadal time span, the lasting evolutionary trends of a stretch of coastline respond to the actions of natural morphogens (variations in storm intensity and frequency, changes in wind and swell orientation, modification of continental hydrology, etc.) or increasingly anthropogenic ones as we approach the contemporary era (harbor structures, sediment extraction, sea defense structures, etc.).

Finally, on the scale of meteorological and marine events, significant changes in coastal forms can be observed during storms, especially if they are coupled with certain tidal conditions on the meso- and macrotidal coasts (high tidal coefficients and high tide). Thus, strong swells, heightened by marine surges often exceeding 1 m related to wind and low atmospheric pressure, can directly attack the tops of beaches and cause, in a few hours, spectacular erosion phenomena: retreat of the coastline of several tens of meters, lowering of beaches, breaches, submersions. Moreover, a succession of stormy events weakens the coasts all the more as the sedimentary compensations that occur naturally after each event do not have time to take place before the arrival of the next storm. These paroxysmal events, which are brutal, generate considerable instantaneous coastal recession rates, but they do not constitute a trend allowing reliable predictions, which only a long period of observation allows.

In this dynamic, the current annual millimeter sea level rise related to climate change, even if it is increasing, is very small compared to the metric height of storm surges. Sea level satellites – TOPEX/POSEIDON, then Jason-1 – show an annual rise of 3 mm since the early 1990s (Cazenave and Llovel 2010). In comparison, the surge recorded at La Rochelle during the Xynthia storm in 2010 was 1.53 m and the quite exceptional surge of the storm of February 1, 1953 in the southwestern Netherlands was 3 m. Thus, in current erosion and flooding events, the eustatic signal related to climate change is weak, masked by one-off events of much greater amplitude. However, the sea level rise predicted by the IPCC for the year 2100, which was estimated in 2013 to be between 26 cm and 98 cm depending on the

predicted CO₂ emissions and the models used, and revised upwards in 2018, cannot be neglected (GIEC 2013, 2018).

Furthermore, it is logical to think that global warming influences extreme weather events, which is already clearly evident in the case of tropical cyclones. In temperate zones, however, where strong regional disparities are apparent, results on this subject are not yet stabilized. In any case, and whatever the intensity of the eustatic rise, it will raise the instantaneous water levels of storm events, increasing the risk of erosion and submersion.

Two other major reasons, directly linked to human activities, aggravate this already unfavorable situation in terms of coastal hazards. On the one hand, the stocks inherited from the cold periods of the quaternary have been diminished by a number of coastal extractions and are now threatened by the growing demand for marine aggregates for construction (ONU 2019). On the other hand, the multiplication of static works to defend built-up areas against the sea freezes the coastline and blocks dune-beach exchanges. It induces effects of thinning beaches and postpones, by exacerbating them, the erosive processes on other sectors (Ministère de l'Écologie 2010).

Global warming thus appears to be a factor that aggravates coastal hazards, but at the moment it is not the driving force in a context that is already very unfavorable to coastal stability.

In addition to its scientific inaccuracy, this amalgam between meteorology and climate (enshrined in the widespread, albeit antinomic, expression "climatic event"), directly linking coastal dynamics and climate change, has a twofold effect on coastal use. On the one hand, it contributes to removing responsibility from the inhabitants and decision-makers behind the urbanization of exposed sectors. This is because climate change is a relatively new paradigm, which was little talked about half a century ago, and because it is a global phenomenon, which tends to be spatially and temporally distant (see section 1.3.2.3). On the other hand, climate change is also an essential tool for awareness raising and prevention, as its mere mention is enough to remind citizens and elected officials that the coast was, is and will remain a territory at risk. It gives more resonance to speeches aimed at limiting the stakes in the coast, and even at considering relocating these stakes toward the land in the perspective of a sustainable development of coastal territories.

However, like all risks, the driving force of coastal risks is not limited to hazards. It is multiple, and also concerns the stakes which tend very strongly, since the 20th century and on a global scale, to multiply near the coasts.

1.2.2. Coastalization of population and activities, the main cause of coastal risks in the world

The phenomenon of coastal settlement and activities, long analyzed by geographers such as D. Noin (1999), has been exacerbated since the second half of the 20th century. The trend is toward a strengthening of the phenomenon, particularly in the low-lying coastal areas of developing countries (Neumann *et al.* 2015).

According to the global synthesis by Neumann *et al.* (2015), five Asian countries (China, India, Bangladesh, Indonesia and Vietnam) accounted for more than half of the world's low-lying coastal population in 2000 and will continue to do so in the future, despite the rapid population growth of several African coastal countries (Figure 1.1). Most of the world's megacities of more than 8 million people are located in the coastal zone, and many are developing in deltaic areas where specific economic, geographic and historical factors combine to drive migration and increase the coastalization of settlement. In China, the growth of coastal urban areas, associated with economic development, is particularly high, more than three times the national rate.

For thousands of years, the world's coastal zones have attracted populations for various reasons depending on the territory and the time. Agricultural, fishing, military, industrial, commercial, leisure or residential reasons have led to the development of activities and the installation of societies near the coastline. This trend has been reinforced for several decades with the development of coastal urbanization and the ever-growing attraction of our contemporary societies to the seashore.

There are several reasons for settling in an area exposed to coastal hazards. For a large part of the world's population, the primary motivation is related to work near the sea. Whether one is a fisherman, a port worker, or a tourism employee, the land-sea interface constitutes a work space. These populations, often socially vulnerable, reside close to their place of work, and therefore frequently in areas exposed to coastal risks. For other populations, the coasts can be places of relegation, for migrants from the sea or for people illegally occupying the public domain, for example, the "fifty steps" zone, in French overseas territories. They are illegal occupants, without property title and in the front line of coastal hazards that are particularly formidable in intertropical climate. Finally, other coastal inhabitants are, on the contrary, privileged populations of the most developed countries who voluntarily seek the proximity of the sea to take advantage of its amenities: a view, direct access to the beach, the beauty of the landscape. This is the case in metropolitan France, for example.

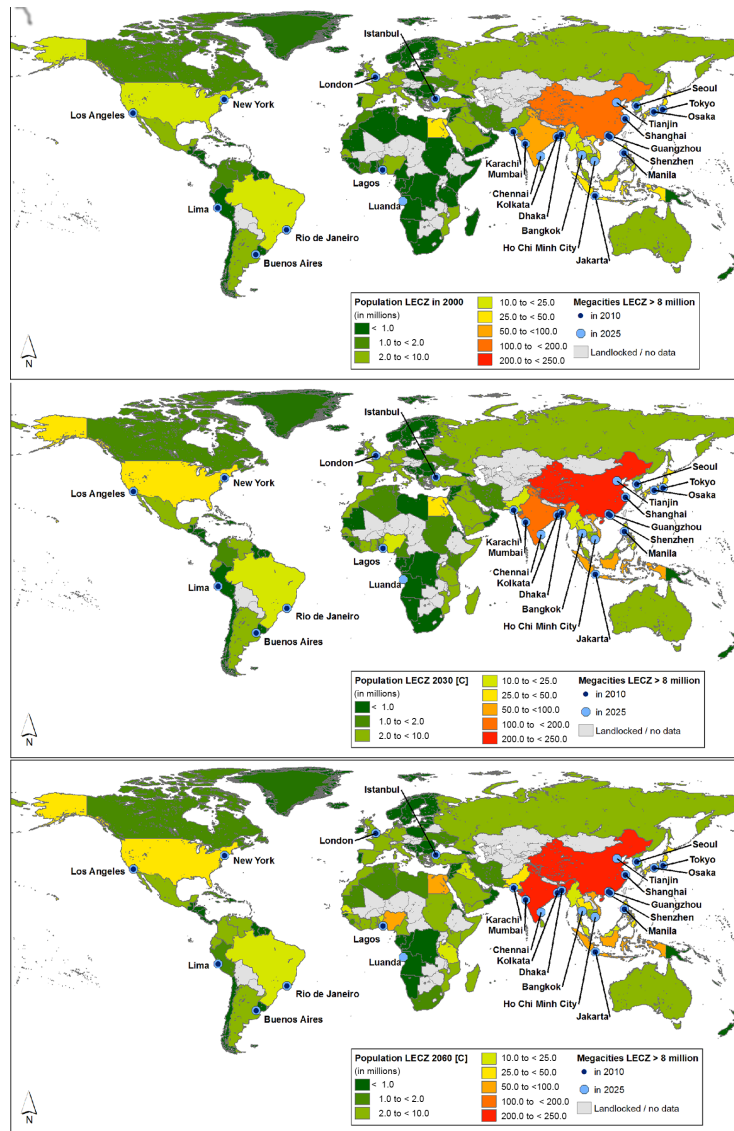


Figure 1.1. Map of the world population in 2000 and the estimated population in 2010 and the projected population in 2025 of a selection of megacities located in low elevation coastal zones (LECZ), according to the UN's world urbanization forecasts. Although the rules of graphic semiology are not followed on this map (population quantity represented by colored solids over the entire surface of the countries), we found it informative enough to keep (source: from Neumann et al. 2015). For a color version of this figure, see www.iste.co.uk/rebotier/risks.zip

1.2.3. Coastal risks caused by the desire for shores

The work of historians reveals that the densification of the occupation of the coasts of Western countries is relatively recent. Until the end of the 18th century, most European coastlines were sparsely occupied (Corbin 1988). The shores did not attract crowds and the occupation of the coastline responded to the needs of activities requiring proximity to the sea. It was thus essentially utilitarian reasons, those of the working coast, that motivated coastal settlements, and not an attraction for a living or leisure environment.

Progressively, representations of the coastline have changed. In parallel with the democratization of society and the transition from a rural to an urban society, the rise of seaside tourism has radically changed the relationship of man to the shoreline. While the seaside became a place for walks and invigorating baths recommended by doctors at the end of the 18th century, the coastal area began to constitute a spatial resource to be exploited for real estate. During the 20th century, the few aristocratic villas built along the coast gradually gave way to more numerous constructions, housing estates and buildings. After the Second World War, many of the old villages that were located a few kilometers from the coastline were duplicated by the creation of seaside resorts located on the shore (Toulier 2016):

The marine dream creates wealth and new forms of conquest of coastal areas. The sandy shores become coveted beaches fixing new seaside cities with only ludic functions, the seaside resorts. (Cabantous *et al.* 2005)

Thus, the rise of seaside tourism, first aristocratic in Europe and then “mass” and globalized, has contributed to the densification of the occupation of the coast and to bringing buildings ever closer to the shore (Figure 1.2). In parallel with the development of tourism, the new image of the coastline, healthy, natural and fun, reinforces a strong residential tropism. This is expressed in the stretching out of residences (primary or secondary) along the shores, from urban, port or seaside centers.

In this context, the coastal risks of erosion and submersion are particular. They do not result from involuntary exposure to a hazard, like most natural and technological risks, but from a desired proximity to a sea that attracts and makes people dream. However, this sea is ambivalent, carrying amenities that are highly prized by socially privileged and mostly urban populations, but also the engine of coastal hazards. The question of social representations of the sea, which change

according to place and time, therefore appears to be essential to understanding the mechanisms that generate stakes, and therefore coastal risks (see section 1.3.2.3).



Figure 1.2. Blankenberge beach, Belgium (source: C. Meur-Ferec, September 2005). For a color version of this figure, see www.iste.co.uk/rebotier/risks.zip

When one crosses this trend of voluntary movement of stakes toward the sea, with that of the retreat of the shores toward the land in a context of sedimentary shortage and rising sea level, one understands the emergence and multiplication of coastal risks, in societies privileged to the Western way of life, during the 20th century. These converging dynamics can be found on most of the world's urbanized seafronts (Figure 1.3).

In this diagram, the “buffer zone” of a few kilometers between the old villages and the coastline was gradually reduced between the end of the 19th century and the beginning of the 20th century. The disappearance of this “safety area” was largely accelerated after the Second World War, during the seaside boom of “mass” tourism, from which the constructions were brought as close as possible to the coastline in order to take maximum advantage of all the amenities offered by the sea. It is in this situation of predictable telescoping between hazards and stakes that the risks of erosion and submersion have emerged. Faced with the appearance of these risks, the reaction of the owners of property exposed to the mobility of the

coastline was to defend them by trying to fix the shoreline, against a natural tendency to regress. Danger spaces have then developed and are maintained permanently, in an artificial way, in a relative and very expensive stability. Climate change and the consequent acceleration of sea level rise clearly appear as factors aggravating the hazards, presaging ever-increasing damage to urbanized coastlines.

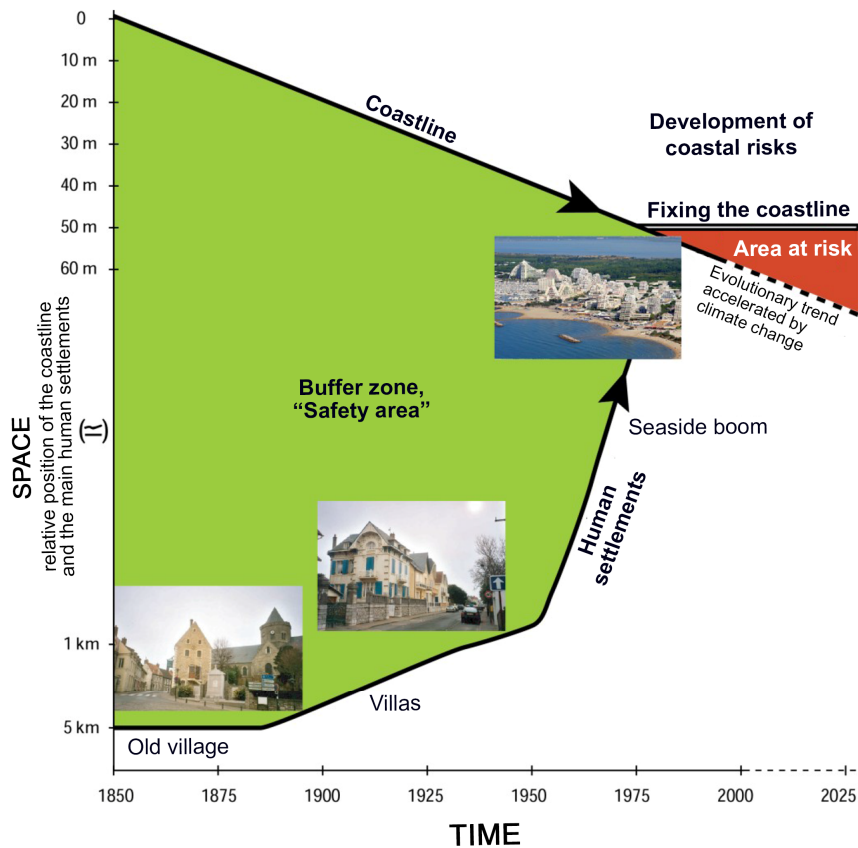


Figure 1.3. Diagram of the emergence and multiplication of coastal risks in the 20th century on the French seaside (source: adapted from Meur-Ferec and Morel 2004). For a color version of this figure, see www.iste.co.uk/rebotier/risks.zip

Analyzing the evolution of hazards and stakes allows us to estimate the evolution of coastal risks, but other dimensions are missing to understand the dynamics and to understand in depth the vulnerability of coastal territories.

1.3. Systemic approach to the vulnerability of coastal territories

Vulnerability is a polysemous term (Birkmann 2006) that offers the possibility of taking a systemic and integrated approach to coastal risks (Meur-Ferec *et al.* 2020). When considered solely as the social component of risk, this concept does not provide the services that one would expect from it in terms of knowledge synthetics and decision support. The concept of “systemic vulnerability” proposed in this section integrates all the factors (natural, economic, political, social) of fragility of a coastal territory. Vulnerability is understood as a system with multiple interacting components.

1.3.1. For an integrated and broadened conception of vulnerability

The scientific literature on the subject of vulnerability is abundant and shows first of all that a consensus is far from being established on its meaning and use (Gilbert 2009). The use of this notion has also developed strongly over the last 20 years in publications concerning the impacts of climate change. Even in the limited field of coastal vulnerability, the diversity of uses of this term remains very large.

Vulnerability is specific to each territory, intimately linked to its history, its use and its population. In this sense, it has an eminently geographical character, as it is strongly place based (Cutter *et al.* 2003; Rebotier 2012). Also, because it is socially situated, vulnerability cannot be studied in a universal way. This is all the more true when we give an important place in its analysis to questions of governance and representations, which are particularly sensitive to social, political or administrative contexts.

Among this proliferation of uses of the notion of vulnerability, we have progressively developed the concept of “systemic vulnerability” to coastal flooding-erosion risks through various research projects (Meur-Ferec *et al.* 2008; Hellequin *et al.* 2013; Hénaff and Philippe 2014). This approach of course builds on previous work, in particular that of Robert D’Ercole (1994), which defines the vulnerability of societies through their capacity to respond to potential crises, a capacity that depends on both incidental (the hazard) and structural (social, economic, cultural, functional, institutional context) factors. One of the particularities of this approach is therefore to consider hazards as an integral part of vulnerability, whereas they are generally studied separately. Integrating hazards into vulnerability makes it possible to avoid “a manicheistic and naive reading of the hazard-vulnerability pair (opposing nature on the one hand and culture on the other)” (D’Ercole and Pigeon 2000).

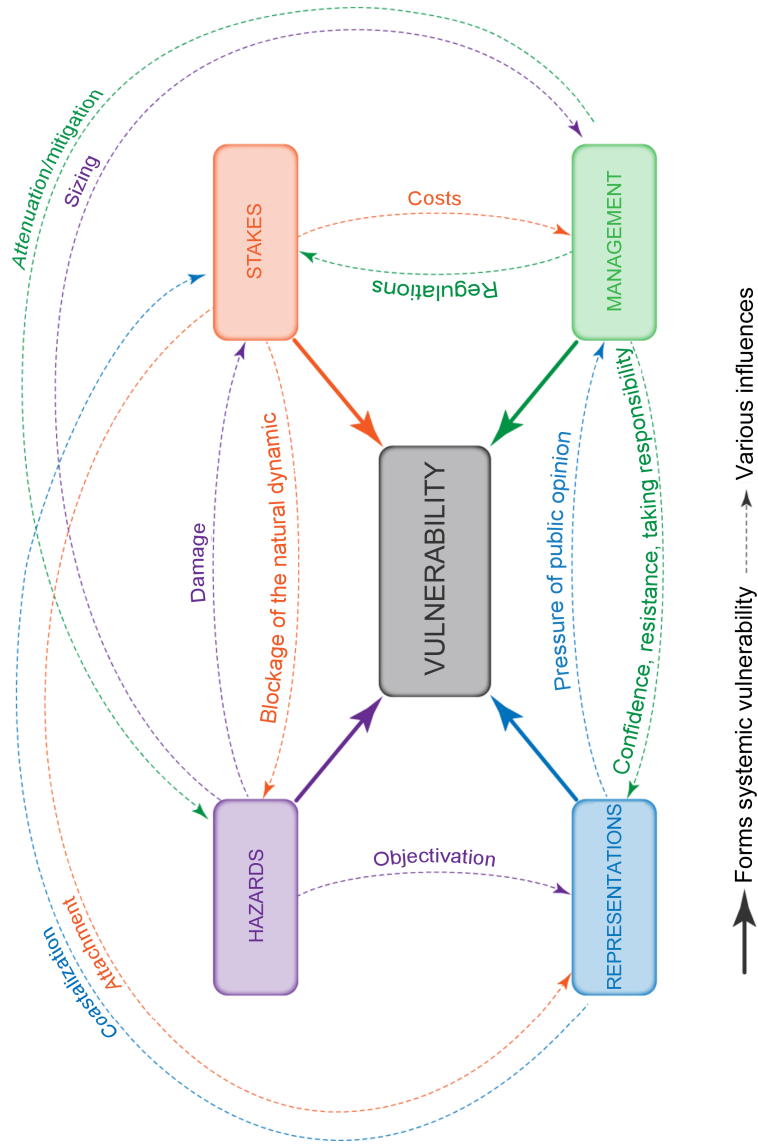


Figure 1.4. Systemic vulnerability diagram (source: from Meur-Ferec et al. 2008). For a color version of this figure, see www.iste.co.uk/rebotier/risks.zip

In this sense, vulnerability is no longer just the social parameter of risk, but becomes a resultant, expressing the fragility of a territory as a whole. Vulnerability as a system is thus the result of the combination of four interdependent components (Figure 1.4). Classically, hazards (1) (in this case coastal erosion and marine submersion) are processes of more or less natural origin likely to damage or destroy the stakes (2) that are exposed to them. The stakes are the people, the goods and the activities that are located in a territory exposed to the hazard. These two components make it possible to define the risk, but are insufficient to assess vulnerability. Two other components are therefore taken into account. Risk management (3) includes public policies for protection, prevention and crisis management and their application by risk management actors in the field. And representations (4) take into account the relationship to risk of the populations present in the territory concerned and of the actors responsible for its management (sensitivity to risk, relationship to place, adaptation preferences, etc.).

These four components combine to form the systemic vulnerability of an area at a given time (Meur-Ferec *et al.* 2008). It is possible to enter the system through any of the components; the important thing is to study the four and take into account their respective contributions to the constitution of vulnerability (Figure 1.4, solid arrows). First of all, hazards and stakes are essential components, because they constitute risk: without either of them there would be no risk, and therefore little interest in assessing management and representations. By the same token, these two components have a decisive influence on the overall diagnosis of vulnerability: if the hazard is low and the stakes are few, a lesser sensitivity of the population to the risk and a management that takes little account of it are of much less importance than if the risk were high. Hazards and stakes clearly increase vulnerability. Management, on the other hand, is in principle conducive to reducing vulnerability (although inappropriate management can have negative effects). The influence of representations on vulnerability is much more difficult to grasp. It can contribute to increasing or decreasing it. Finally, the four components are largely interdependent (Figure 1.4, dotted arrows). For example, management influences the stakes by regulating construction in exposed areas; representations of the coast as a privileged place to live influence the stakes by increasing the coastalization of the population; hazards influence management by conditioning the choice and dimensioning of protective structures, etc.

The systemic vulnerability approach therefore involves a multi-criteria analysis. It also makes it possible to identify the components that contribute most to overall

vulnerability. Depending on the area, this may be due to high hazards, a high concentration of stakes on the coastal fringe, a lack of consideration of risk in urban planning documents and/or a lack of interest on the part of inhabitants.

1.3.2. The systemic vulnerability of coastal areas in France

Analysis of systemic vulnerability is difficult to consider at the global level. However, it is possible to outline the major trends in the four components of systemic vulnerability at the scale of metropolitan France.

The current French context has been strongly marked by the dramatic event of the Xynthia storm in 2010, which caused 47 deaths on the Atlantic coast and placed coastal risks at the forefront of media and political scenes. It revealed the extent of the phenomenon and the complexity of the problem in a country that has relied on the residential and tourist development of its coasts.

1.3.2.1. Hazards: part of the problem

Metropolitan France is sheltered from tropical cyclones; it is not subject to major tsunamis or strong subsidence; its varied topography does not predispose it particularly to submersion; and the lithological diversity of its coasts gives it variable erosion speeds. Compared to other regions of the world, such as Southeast Asia or the Caribbean for example, it is not particularly exposed to coastal hazards, even if some parts of its territory are very sensitive, especially in the overseas territories. However, many studies are devoted to coastal hazards. Within the framework of PPRNs, their mapping is the subject of sophisticated hydrodynamic modeling and gives rise to passionate debates on water heights and recession speeds (Perherin *et al.* 2017). Numerous coastline observatories are organized in a network by the Ministry of the Environment, which commissioned the mapping of low-lying coastal areas and the national erosion index following Xynthia (Figure 1.5).

Coastal hazards are often aggravated by human actions. Extraction of sand and pebbles is now strictly regulated on land and in the shallows, but the sedimentary stock has been heavily exploited since the Second World War, mainly by the construction industry. For example, the pebble strip in Audierne Bay, which was mined for decades to make concrete, has lost more than half its pre-war volume (Figure 1.6).

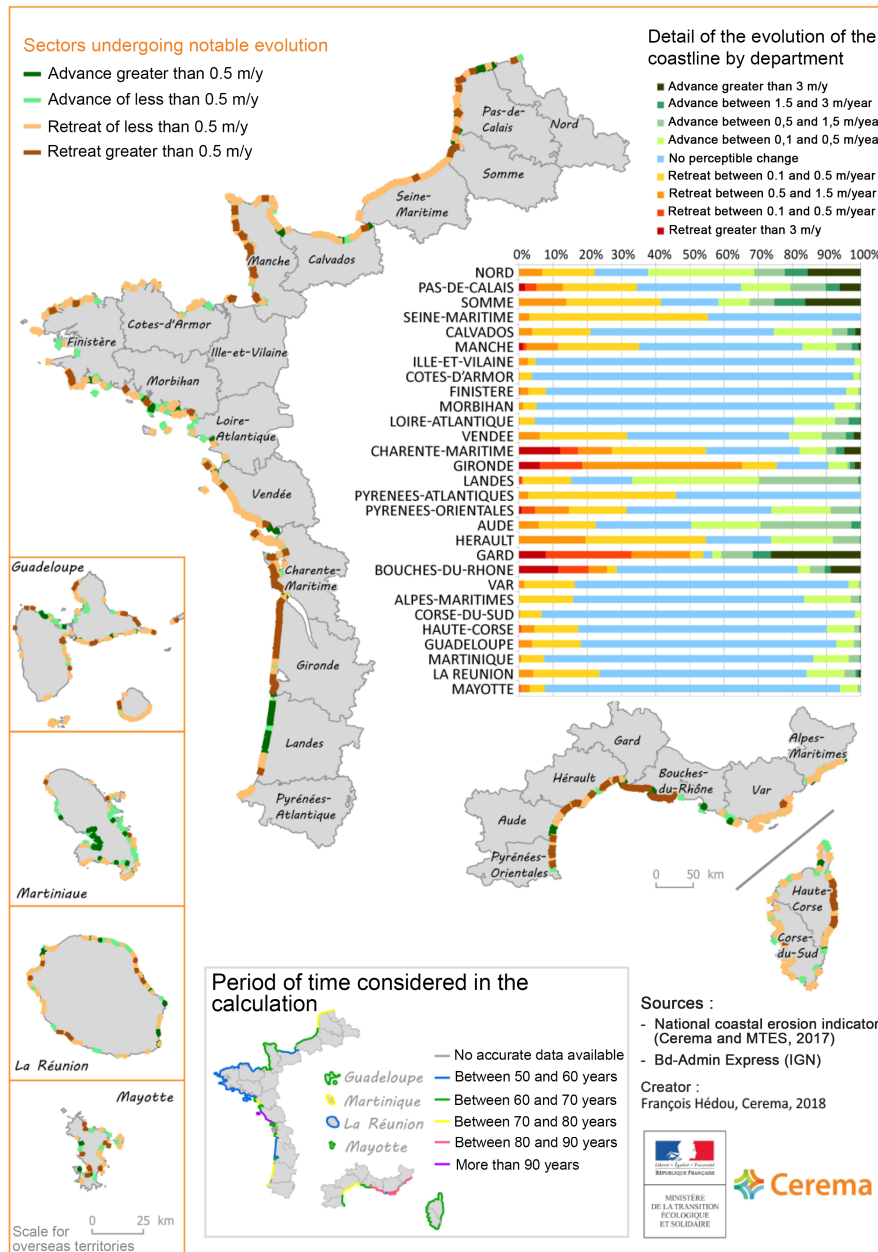


Figure 1.5. Map of the national coastal erosion indicator in France (source: Cerema 2018). For a color version of this figure, see www.iste.co.uk/rebotier/risks.zip



Figure 1.6. *Remains of the pebble crushing plant of Tréguennec, Audierne Bay, France (source: C. Meur-Ferec, 1989). For a color version of this figure, see www.iste.co.uk/rebotier/risks.zip*

In addition, according to a cartographic inventory carried out by the Center for Studies and Expertise on Risks, Environment, Mobility and Development (Cerema 2018), about 16,000 structures and developments are present on the French coastline, over a cumulative length of 2,300 km. These structures, which have increased significantly since the 1960s, artificialize about 30% of the coastline. While their purpose is to fix the shoreline in high-stake areas, they have secondary effects on the erosion of beaches and adjacent areas (Figure 1.7). They contribute both to reducing the hazards of submersion and erosion in a localized manner, and to increasing them in the long term by hindering the natural mobility of the coasts and reducing their capacity for resilience.

As in other coastal areas of the world, the trend toward erosion and submersion of the French coastline is expected to continue or to increase in a context of global warming and a largely depleted sedimentary stock.

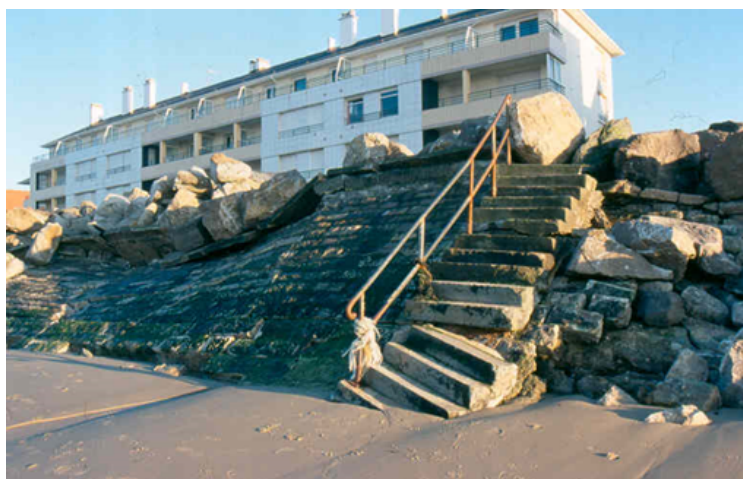


Figure 1.7. Lowering of the beach at the foot of a structure, Wissant, France (source: C. Meur-Ferec, 2003). For a color version of this figure, see www.iste.co.uk/rebotier/risks.zip

1.3.2.2. *The stakes: the heart of the problem*

In terms of human lives at risk, France is not among the territories with the highest stakes in the world. Unlike countries such as Bangladesh and Indonesia, for example, the majority of French coastal populations are well housed, informed and financially well off. On the other hand, in terms of exposed property, the French coastline concentrates important built-up areas, the construction of which has been stimulated by a national spatial planning policy which, since the 1960s, has relied heavily on the development of seaside tourism (planning missions for the Languedoc-Roussillon coast in 1963 and the Aquitaine coast in 1968). On other coasts, such as Brittany or the Côte d'Azur, construction developed more spontaneously, but also exponentially in the second half of the 20th century.

In addition to their number, the value of homes exposed to coastal hazards reaches peaks¹ that do not weaken despite damaging events, and even dramatic episodes like Xynthia. The average sale price of building land in coastal municipalities was 60% higher than the average for metropolitan France in 2012 and has continued to rise, increasing by 40% between 2006 and 2012 (SOeS 2013).

¹ Law no. 86-2 of January 3, 1986 relative to the development, protection and enhancement of the coastline.

Nothing in the real estate markets seems to indicate a reversal of this trend². This point constitutes one of the nodes of the problem of coastal risk management in France, as such real estate values do not allow for public land control of the most exposed properties, as foreseen in the national strategy for integrated coastline management (Ministère de l'Écologie 2012).

This coastalization of the population, and especially of constructions that consume a lot of space, is continuing today, even if the Coastal Law of 1986 and the Barnier law of 1995 (establishing the PPRNs) have regulated the large amounts of coastal urbanization taking place. Today, coastal municipalities, which represent 4% of the surface area of mainland France, concentrate more than 10% of the population (which can be multiplied by 10 in the summer season), 12% of new housing surfaces, 23% of second homes and 37% of the country's tourist accommodation capacity (Ministère de la Transition écologique 2017). Thus, coastal issues have multiplied closer to the sea for more than half a century. As the craze for seaside residences grew, construction moved closer to areas exposed to coastal hazards.

In addition to their number, the value of homes exposed to coastal hazards reaches peaks⁵ that do not weaken despite damaging events, and even dramatic episodes like Xynthia. The average sale price of building land in coastal municipalities was 60% higher than the average for metropolitan France in 2012 and has continued to rise, increasing by 40% between 2006 and 2012 (SOeS 2013). Nothing in the real estate markets seems to indicate a reversal of this trend⁶. This point constitutes one of the nodes of the problem of coastal risk management in France, as such real estate values do not allow for public land control of the most exposed properties, as foreseen in the national strategy for integrated coastline management (Ministère de l'Écologie 2012).

The understanding of such a craze for seaside residence, in a context of coastal risks exacerbated by climate change, is to be sought in representations of the sea and of coastal residence.

2 Law no. 95-101 of February 2, 1995 relating to the reinforcement of the protection of the environment.

3 Law no. 86-2 of January 3, 1986 relative to the development, protection and enhancement of the coastline.

4 Law no. 95-101 of February 2, 1995 relating to the reinforcement of the protection of the environment.

5 Eugénie Cazaux's thesis in progress: *Effects of the ambivalence of the sea on the land and property values of the French coastline: coastal risks and climate change versus desire for the shoreline*. LETG Laboratory, University of Brest.

6 As shown in a publication of *Le Monde* online titled on August 2, 2018 in the Money & Investments section, "Real estate prices are rising everywhere on the French coast".

1.3.2.3. *Representations: a main component often forgotten*

The “representations” component has long been neglected in risk studies, but its importance was dramatically highlighted in France by the Xynthia storm disaster (Hellequin *et al.* 2013). Several studies on this topic have analyzed the results of surveys conducted among residents of communes exposed to coastal risks, on different coasts of France (Hauts-de-France, Occitanie, Brittany) (Michel-Guillou and Meur-Ferec 2017; Meur-Ferec and Guillou 2020). Among the main results, we note that:

- contrary to certain initial hypotheses, the inhabitants interviewed are not ignorant of coastal erosion and submersion processes. However, the vast majority of them do not spontaneously think of these phenomena when risks are mentioned in their community. They are not worried because they do not “objectify” them as risks (Moscovici 2001). “A big gust of wind” or “a little water in the house” are elements they have chosen to live with, without thinking about them daily in terms of risk;

- coastal risks related to climate change are known, but little mentioned at local level. Inhabitants situate these risks outside their place of residence (“it’s in Bangladesh”), or on a temporal scale beyond their lifetime (“in 2100, I won’t be here anymore”). Distancing oneself from the risk helps to maintain a sense of well-being. It distances the dangerous phenomenon by making it an abstraction (Trope and Liberman 2010);

- erosion and flooding are not perceived as an insurmountable problem. The inhabitants concerned feel that they are manageable through prevention and protection measures. The knowledge of the environment, combined with this sense of control, allows individuals to maintain the positive identity of their place of living;

- living near the sea is considered above all as an advantage, and even as a privilege. We find here the attraction for the coastline and its positive image, characteristic of contemporary Western societies, which largely conceals the dangers of proximity to the sea;

- in terms of development, the preference for hard structures, aimed at fixing the coastline to protect property, can be linked to the identity dimension of attachment to a place. Thus, coping strategies are accepted as long as they do not lead to changes that result in too much modification of living spaces or relocation, and thus do not interfere with the identity of the place of habitation (Twigger-Ross and Uzzell 1996). Otherwise, a process of resistance tends to lead people to generally endorse national or international strategies, such as relocation, while pointing out the impossibility of their local realization. In addition, political factors, such as strong

public intervention to repair damage and compensate property owners, also help explain people's sense of control and their willingness to "hold the line".

Knowledge of representations is an essential element of knowing the systemic vulnerability of a territory. Not only does it allow for a better understanding of public policy orientations and management choices, but also, through the representations of the inhabitants, to explain certain difficulties in implementing national strategies at the local level.

1.3.2.4. *Management: the lever of public policies*

In France, the principles of the welfare state remain strong, compared to other countries that are more liberal economically and socially, such as the United States or Canada. Thus, the management and induced costs of coastal risks are traditionally borne by the public authorities, which regulate urbanization and finance most sea defense works (Meur-Ferec and Rabuteau 2014). In addition, victims of "natural disasters" benefit from a public compensation system based on national⁷ solidarity (Cazaux *et al.* 2019). Today, however, in a context of scarce public funds and rising sea levels, and after the Xynthia disaster in 2010, coastal risk management is undergoing significant changes.

First, the State has accelerated measures to control urbanization in coastal areas by identifying 58 priority coastal PPRNs in 2011. Their implementation, involving strict restrictions on building authorization in hazard zones, revealed the often conflicting debates between the State, accused of being too secure, and local authorities, suspected of prioritizing the development of their territory and the defense of their constituents' interests to the detriment of the general interest (Perherin *et al.* 2017). In addition, in 2012, the government implemented the National Strategy for Integrated Coastline Management advocating the relocation of stakes and activities most at risk (Ministère de l'Écologie 2012; Mineo-Kleiner and Meur-Ferec 2016). A governmental reflection is underway on the feasibility of a "spatial recomposition of coastal territories" in a context of climate change (Buchou 2019; CGEDD 2019). If the State encourages the destruction and the retreat of certain stakes, almost no actor on the ground concretely considers this option. The choice of withdrawal, in addition to the immense financial problems it poses in terms of real estate values on the coasts, clashes with social representations of a dreamed coastline. However, it is to be hoped that the specter of climate change and the highly publicized "rising sea level" will help to move things forward in this perspective.

⁷ This system, which is not well adapted to coastal risks, covers flooding and landslides on rocky cliffs, but not dune erosion.

At the same time, and in an often disconnected and even contradictory way, the National Strategy for Flood Risk Management (2014) recommends that local authorities set up action plans for flood prevention (Papi), which opens up state funding for them to create or strengthen sea defenses. Thus, territories that are subject to both erosion and flooding hazards (which is very common on soft coasts where they are intrinsically linked) have every interest in adopting the strategy of flood risk management rather than coastline management if they want to strengthen their position near the sea. Only territories exposed to erosion risks alone are forced to consider long-term adaptation to climate change.

Another significant fact in terms of management is that the welfare state is gradually disengaging, as evidenced by the recent transfer of the “management of aquatic environments and flood prevention”⁸ competency to municipalities and their groupings since 2018. The “flood prevention” competency concerns the control and financing of works against river and marine flooding and is therefore a central competency in terms of coastal risks. This decentralization of the management of sea walls constitutes a major upheaval in the current governance of coastal risk management in France. On the one hand, we can hope that it will lead to a greater responsibility of coastal territories and inhabitants. On the other hand, we may fear that it will allow some, the richest, to free themselves from the principles of sustainable development and adaptation to climate change and that it will accentuate inequalities between coastal territories. These considerations on coastal risk management underline that it is less a technical problem than a political one. It raises questions of land use planning, social choices, adaptation to a changing environment and social equity.

In the end, if the hazards and human stakes give France a moderate level of risk on a global scale, the vulnerability of the French coastline is mainly due to two components: on the one hand, public policies that struggle to make inhabitants responsible, without sacrificing the principle of national solidarity, and, on the other hand, a low representation of coastal territories as areas at risk. These two elements, linked together, constitute powerful brakes on the challenge of adaptation posed by climate change.

Thus, the systemic vulnerability approach makes it possible to integrate all the dimensions necessary for understanding territories subject to coastal risks. It underlines the need to go beyond hazard-centered approaches, but also to go beyond purely sociocentered research that ignores natural dynamics. It is in the systemic approach, dear to geographers, that the vulnerability of coastal eco-socio-systems

⁸ Maptam law of January 27, 2014 on the modernization of territorial public action and the affirmation of metropolises.

can be understood in all its complexity. This understanding can provide enlightening elements for managers in the field (local and state government departments, elected officials), at this Anthropocene time.

1.4. Interests and limits of the Anthropocene moment for thinking about coastal risks

The integrated approach of systemic vulnerability underlines the complexity and multi-causality of coastal risks as well as the importance of their territorial contextualization. Nowadays, the notion of the Anthropocene is regularly mobilized to give a framework and meaning to the “global” issues of the moment. In this last section, and as a reflexive look at the research experience, we will start from some key elements specific to this notion to estimate its interest and limits in the analysis and management of coastal risks.

1.4.1. *The world as a place*

The Anthropocene is thought of above all on a planetary scale. While this scale can be meaningful for defending major causes such as the protection of resources and the natural environment, it quickly reaches its limits. It is impossible to understand a territory’s mechanisms of vulnerability without anchoring the analysis to the scale of eco-socio-systems, which are necessarily restricted to present a minimum of homogeneity. The analysis of risks implies a necessary territorialization, in the sense of being anchored in the field, which is dear to geographers (November 2002; Rebotier 2012).

1.4.2. *Man, an actor with a strong influence on the environment*

The notion of the Anthropocene emphasizes the important place of humans (and their responsibility) in major environmental issues. Integrating the human dimension into understanding of the environment and risks is by definition a matter of course for geographers who study nature–society relations. The relatively new Anthropocene approach does not therefore revolutionize our research on natural risks, which is undoubtedly a social construct (Pigeon *et al.* 2018). The Anthropocene is perhaps more useful to the geosciences and the “biosciences” in asserting their place in research on major environmental issues, which are unavoidable in the majority of calls for projects.

1.4.3. The protection of the natural environment at the heart of all issues

Environmental concerns are taking a prominent place, as markers of an anthropocene moment. However, although they are undoubtedly important, they are not the subject of coastal erosion and flooding risks or of natural risks in general. Natural risks are not a problem of nature, but a problem of humans confronted with natural constraints. The desire to include the protection of nature in all research topics probably responds to the strong influence of certain disciplines (such as ecology), the militant commitment of certain researchers and the political orientations of research programming. Since the 2000s, ecological concepts have been used in all subjects: the eco-socio-system of the 1990s has been transformed into a more bio-centric “socio-eco-system”, “ecosystem services” are revaluing nature economically, “nature-based solutions” are renewing the engineering sciences, and the “Anthropocene” is offering a new era for the natural sciences, which are reconnected with society.

An example of the limits of these “environmentalist” recommendations is the way in which “nature-based” solutions are presented, by the Ministry of the Environment in particular, as innovative, even revolutionary, responses to coastal risks: the idea, which is quite logical in absolute terms, is to leave buffer spaces (marshes, mangroves, coastal dunes) on the seafront to absorb the energy of storm swells and the rise in sea level. In terms of sediment dynamics, the principle is quite judicious. The problem, for the moment unavoidable, is that social dynamics have made these sectors bordering the sea very coveted spaces, often occupied by constructions of great economic value protected by hard structures that should be deconstructed to let the natural dynamics play. This is the idea of relocation which, as we have seen, comes up against strong social reticence and problems of public expenditure, which have been insurmountable until now. Thus, the heart of the problem is not to understand natural dynamics, but the social dynamics that have strongly transformed the coasts. These nature-based solutions are quite applicable, but on natural spaces, which *a priori* are not or hardly threatened by coastal risks.

1.4.4. The use of nature as a compelling argument

Presenting coastal risks under the prism of environmental protection leads to an amalgam that some elected officials, and especially the associations of local residents and second homeowners who are looking after their privileges, know how to use skillfully. Environmental considerations are used as irrefutable arguments. Protection of nature and protection against the sea are presented as one and the same fight, whereas they are almost opposite positions. By placing nature protection as a

priority issue, the notion of the Anthropocene does not help to disentangle particular interests from the general interest in coastal risks.

1.4.5. A social utility?

Although the notion of the Anthropocene does not seem to have any particular innovative contribution, it can have real social utility as a propitious moment for paradigm inflection. In fact, it is “fashionable” and attracts media attention and, in this sense, it can encourage a more respectful occupation of the coasts of natural dynamics and raise awareness of the necessary measures of adaptation in a context of climate change. However, this potential lever for action is not without major drawbacks, as mentioned above.

1.5. References

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