Public perception of engineering-based coastal flooding and erosion risk mitigation options: Lessons from three European coastal settings

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A B S T R A C T

Recent damages and losses associated with coastal floods have generated many analyses dealing with overexposure to flood risk, its consequences, associated technological choices and governance principles, and what seems to be a poor understanding of the causes and consequences of floods and working of coastal defences at the local level. While many analyses demonstrate that risks are both physically and socially constructed, in this paper we go further by analysing risk mitigation options (engineering works) as being dual (physically and socially constructed) as well. When envisioning mitigation options through stakeholders’ perception, one can observe a mix of intertwined statements associated with the relevance the specific risk that is dealt with, dealing with the sometimes incomplete knowledge associated with the mitigation option and its performance at reducing risk, and, dealing with the value conflicts that may be present when envisioning a particular flood risk mitigation strategy. Our research question is “what are the drivers of stakeholder perceptions when envisioning engineering-based mitigation options?” Through qualitative empirical fieldwork conducted in three European coastal settings (Cesenatico, Santander and the Gironde Estuary) we demonstrate here that engineered mitigation solutions are socially construed by referring to individual and collective heuristics associated with these options. These heuristics may lead to poor social acceptability of envisioned mitigation options, poor acceptability not directly linked to the performance in terms of risk reduction.

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1. Introduction

In this paper we identify the drivers of the stakeholders attitude toward a specific category of coastal risk mitigation: engineering-based risk mitigation options. Most risk perception analyses deal with the way individuals or groups relate to uncertain events and their associated outcomes. In this paper we enter the “risk perception” analysis through a different entry point: the risk mitigation options.

Recent damages and losses associated with coastal floods have generated many analyses dealing with overexposure to flood risk, its consequences, associated poor governance principles (Eisenman et al., 2007), and what seems to be a poor understanding of the causes and consequences of floods (Burby, 2006; Schneider, 2005). This “poor understanding” points toward a need to reinforce the science-policy interface.

Yet this has been mostly approached by attempts at informing the public and policymakers in order to fill a perceived “knowledge gap”. This “knowledge gap hypothesis” is very much contested. There is ample evidence that knowledge is not the sole determinant of risk (mis-)perception (e.g., Kahan et al., 2012).

More recently, integrative approaches to the analysis of risk perception have been proposed (Renn, 2008) stressing the fact that risk perceptions are determined by collective and personal manifestation of cultural backgrounds, socio-political institutions, cognitive affective factors and heuristics of information processing. This diversity of these potential sources of (mis-)perceptions indicates how judicious it may be to try to address one of these in order to modify attitudes.

When envisioning risk mitigation strategies and options the issue of perception is complexified by the mitigation option choice itself. Risk mitigation options raise perception issues as well. Furthermore, the concrete nature of a mitigation option implementation, its direct visibility to those affected, its existence, even if the risk does not concretize itself, may lead to a differential framing of the option chosen and of the risk under consideration. Finally, mitigation option may raise acceptability issues as some options may profoundly change the landscape, potential land use, real estate values and the likes.
While many analyses demonstrate that risks are both physically and socially constructed, in this paper we go further by analysing risk mitigation options (engineering works) as being dual (physically and socially constructed) as well.

This paper answer to some of the question identified above by exploring empirically the following research question: “What are the drivers of stakeholder perceptions when envisioning engineering-based mitigation options?”

In Section 2 (this Introduction being Section 1) we present a synthesis of the theoretical frameworks that we are using, we define the type of mitigation option under scrutiny and present the associated working hypothesis. Section three briefly presents the method that has been used for the empirical part of our work. Section 4 presents and discusses the results that were obtained. Section 5 concludes this paper.

2. Central concepts and working hypothesis

2.1. Risk and perception, toward an integrative framework and its application to coastal risks

Risk is a mental model (Renn, 2008, p.2). Part of this model is linked with reality as it may manifest itself (some will call it the hazard, others will associate a probability density function with the description of an event) and part is linked with the way individual and society frame this manifestation (some may call this the consequence). By “framing” we mean here: how individuals talk about, and then assess the risk, taking into account contextual elements that seems neither directly linked with the probabilistic nature of risk nor with its consequences. Framing leads to situation where risk assessment by experts and risk assessment by laypersons lead to dissonant conclusions that may lead to sub-optimal behaviours, ill designed and/or not well accepted risk management options.

Therefore, what is understood as “risk”, “risk management”, “risk assessment” and the likes may cover diverse realities. While this is not a difficulty in itself, it raises several challenges when identifying a risk worth managing, when choosing the management option and when setting the risk governance mechanism. The analysis of this diversity has been the focus of the active and diverse literature on risk perceptions. Key elements of this literature are presented here as well as its potential interest to the analysis of engineering-based coastal risk mitigation options. Several theories constitute the main stream in risk perception since the 80s. We chose to focus on the followings: the psychometric approach to risk, the cultural theory of risk, the social amplification of risk, the governmentality approach to risk and the synthesis recently produced by Renn (2008).

Psychometrics deals with the quantification and prediction of risk and is probably the leading contender in the field (Sjöberg, 2000); according to Slovic (1992), the perceived risk is somehow quantifiable and predictable and one of the main questions is: “how much risk people say are they willing to accept?”. The three main factors are: 1) the degree to which a risk is understood, 2) the degree to which it evokes a feeling of dread and, 3) the number of people exposed to the risk. An approach for studying perceived risk is to develop taxonomies for hazards that can be used to predict attitudes toward their risks. A taxonomy scheme might explain, for example, people’s extreme aversion to such hazards, their indifference to others, and the discrepancies between these reactions and experts’ opinions. The most common approach to this goal has employed the psychometric paradigm (Fischhoff et al., 1978; Slovic et al., 1984), which uses scaling and multivariate analysis techniques to produce quantitative representations of risk attitudes and perceptions. Within the psychometric paradigm, people make quantitative judgments about the current and desired riskiness of diverse hazards and the desired level of regulation of each (Slovic, 1992). These judgments are then related to judgments about other properties, such as (i) the hazard’s status on characteristics that have been hypothesized to account for risk perceptions and attitudes (for example, voluntariness, dread, knowledge, controllability), (ii) the benefits that each hazard provides to society, (iii) the number of deaths caused by the hazard in an average year, (iv) the number of deaths caused by the hazard in a disastrous year, and (v) the seriousness of each death from a particular hazard relative to a death due to other causes (Slovic, 1992). While the psychometric approach has been widely used to quantify relative perception of risk, it seems of little use when envisioning options for risk mitigation. Acknowledging the need for action, does not necessarily define the attitudes toward modes of action.

In the seminal “Risk and Culture” (Douglas and Wildavsky, 1982), one can read: “can we know the risks we face, now or in the future? No, we cannot; but yes, we must act as if we do. Some dangers are unknown; others are known, but not by us because no one person can know everything. Most people cannot be aware of most dangers at most times. How, then, do people decide which risks to take and which to ignore? On what basis are certain dangers guarded against and others relegated to secondary status? “Risk and Culture” attributed political conflict over environmental and technological risks to a struggle between adherents of competing ways of life associated with the two dimensions “group” and “grid”. A “high group” way of life exhibits a high degree of collective control, whereas a “low group” one exhibits a much lower one and a resulting emphasis on individual self-sufficiency. A “high grid” way of life is characterized by conspicuous and durable forms of stratification in roles and authority, whereas a “low grid” one reflects a more egalitarian status. Therefore, egalitarian (“low grid”) and collectivist (“high group”) cultures gravitate toward fear of environmental disaster as a justification for restricting commercial behaviour productive of inequality, and individualistic (“low group”) and hierarchical (“high grid”) cultures resist claims of environmental risk in order to shield private orderings from interference, and to defend established commercial and governmental elites from subversive rebuke. This cultural theory is of interest when envisioning coastal risks because it indicates that risk, and risk mitigation options, and perceptions may very well be defined by factors that are not necessarily directly connected to knowledge. Risk assessment and mitigation may encounter difficulties associated with norms and tradition. The setting up of engineering-based mitigation options may lead to attitudes toward these options that are influenced by cultural factors as defined above rather than by the performance in terms of risk mitigation of the option that is envisioned.

The concept of “social amplification of risk” suggests that the actions of the media, government, and nongovernmental organizations, as well as disputes among scientists, can significantly increase or decrease public risk concerns (Kasperson et al., 1988). The social amplification of risk theory is of interest when analysing coastal risks because of the importance of climate change. Climate change is a field where controversies have been making the headline news. Furthermore conducting field level research on risk is an information gathering, mobilizing and knowledge creation activity, which in itself may contribute to social amplification dynamics. “Governmentality” theory deals with new style of governance in modernity where the risk is mainly understood as entirely socially it makes no sense to ask for more or less risk or how real risks are (Foucault, 2004). Governmentality emphasises the diversity of forms that risk takes as a governmental technique, and stresses their very different implications for those who are governed. It focuses on governmental plans and programmes. Within this framework it is argued that the relevant hazards may be unilaterally and centrally defined by those holding the power. As such hazards and therefore risk can be instrumentalized by governments pursuing objectives (hidden agendas) not pertaining to risk per se. Within coastal context, climate change may thus be framed as an opportunity for governments to regain control of coastal areas.

Combining these various theoretical and empirical approaches, Renn and Rohrman (2000) and Renn (2008) have been proposing an integrative model of risk perception (Fig. 1).

This model acknowledges the fact that risk perceptions are influenced both by collective influences and the personal manifestation of these influences. Furthermore this model acknowledges the fact that
these influences belong to the cultural sphere, to the socio-political arenas, to cognitive affective factors and to heuristic and information processing (Renn, 2008).

These determinants lead through their integration to claim by risk stakeholder dealing with (1) what is good, tolerable, and/or acceptable, (2) what matters to society, what are the important phenomena that should receive our attention and, (3) causal linkages. Stakeholders’ discourse is thus embedded in a “Claims triangle” (Fig. 2). Accessing the relative importance of the claim categories, and qualifying the content of these claims, gives an access to the determinants of perceptions.

This integrative framework, combined with the elements given above on psychometrics, cultural theory, social amplification and governmentality will be used here after to develop an understanding of the way stakeholder perceive engineering-based coastal risk mitigation options.

2.2. Engineering-based mitigation options: an ad hoc THESEUS-centred and SPRC-based typology

In order to establish what an “engineering-based coastal risk mitigation option” is, we have chosen to focus on the observations and developments made within the THESEUS project (Zanuttigh, 2011; Zanuttigh et al., in this volume). We used the project’s official deliverables (Burcharth, 2012; Nicholls, 2011; Vanderlinden, 2012) in order to identify and typify these options. We then identify their rationale for intervention within the Source Pathway Receptor Consequences (SPRC) framework as applied within the THESEUS project (Narayan et al., in this volume). It must be stressed here that the SPRC framework corresponds to a simplified representation of the coastal system that is particularly powerful when envisioning the choice of an engineering-based risk mitigation option. Yet this simplification somehow erases the complex nature of the coastal system; this is not necessarily neutral (Kane et al., 2014-in this volume).

Table 1 presents the types of engineered mitigation options that we identified, as social scientists analysing perceptions, examples of these, and key features in a SPRC framework.

2.3. The question at hand revisited and working hypothesis

In the light of Sections 2.1 and 2.2 above we can refine our general question: “what are the drivers of stakeholders’ perceptions when envisioning coastal risk and engineering-based mitigation options?”

First, we need to ascertain whether the mitigation options raise value-laden issues, this in line with the “cultural theory” and with the normative claims of Renn’s (2008) integrative framework. This leads to a first working hypothesis: “Engineering-based mitigation options generate normative claims in stakeholders’ discourses and these normative claims play a role in the definition of stakeholders’ attitudes toward the risk mitigation options”.

Second, we need to ascertain whether the mitigation option raises pertinences issues (i.e. are the assets protected well chosen), this coherently with the psychometric framework and the integrative framework. This leads to a second working hypothesis: “Engineering-based coastal risk mitigation options generate pertinence claims in stakeholders’ discourses and these pertinence claims play a role in the definition of stakeholders’ attitudes toward the risk mitigation options”.

Third, associated with the governmentality theory, social amplification theory and with the integrative framework, we need to explore whether the causal chains that are mobilized in the design and choice of engineering-based risk mitigation options are congruent with the way stakeholders understand and describe, explicitly or implicitly the functioning of the coastal system. This leads to our third working hypothesis: “Engineering-based coastal risk mitigation options generate...”
evidence claims in stakeholders’ discourses and these evidence claims play a role in the definition of stakeholders’ attitudes toward the risk mitigation options”.

3. Material and methods

In order to conduct our analysis we used a corpus consisting of transcribed semi directed interviews with coastal risk stakeholders. This corpus consists of 32 transcribed semi directed interviews in three European locations with very different coastal risk settings: the Gironde estuary, France (9 interviews); Santander, Spain (12 interviews); and Cesenatico, Italy (11 interviews). The interview framework was built around an aerial photograph of the site, the identification of areas at risk of flooding or erosion, and the discussion of current or envisioned engineering-based solutions. The average duration of interviews amounted to 50 min (minimum of 17 min, maximum of 73 min). Transcriptions averaged 1812 words (minimum of 882 words, maximum of 3089 words). The sample size has been defined by saturation: constant comparisons are made between the developing theory and the raw data until no new findings or views emerge regarding a concept or category. The sampling was designed in order to capture a high variety of differing experiences in relation with coastal risk stakeholders. The key characteristics of the interviewees’ sample may be found in Kane et al. (2014-in this volume).

The data analysis was conducted using iterative-grounded theory. Grounded theory is a systematic methodology in social science involving the discovery of theory through the analysis of (essentially) qualitative data (Strauss and Corbin, 1997; Charmaz, 2006; McCreaddie and Payne, 2010). Iterative-grounded theory consists of using a general conceptual framework to conduct a thematic analysis, this order to build a bottom theorization in close relation with an existing framework. The existing conceptual frameworks that were chosen are Renn’s integrative framework for risk perceptions, mitigation option typology, and SPRC, all presented above.

The 32 interviews were thus first coded using:

- pre-set categories pertaining to Renn’s conceptual model: “relevance claims” identifying quotes where the interviewee states what is a phenomenon worth attention; “evidence claims”, identifying quotes where the interviewee establishes causal linkages related to coastal flooding and; “normative claims”, identifying quotes where the interviewee states what is good, acceptable and tolerable regarding coastal flooding risk management options;

- pre-set categories pertaining to engineering-based risk mitigation options: these categories corresponds to the “type of interventions” listed in Table 1 above;

- pre-set categories pertaining to risk mitigation options within the SPRC framework: “source”, “pathway”, “receptor” and “consequences”.

The choice of these thematic categories had been guided: (a) by the need to acknowledge the evaluative dimension of our research question, evaluation captured within the stakeholders’ discourse through the various claim categories; (b) by the need to see how clearly defined mitigation options (intervention types) were contextualized (SPRC). The choice of these initial coding themes allowed for the identification of emerging themes directly connected to our research question.

In the course of the coding it appeared that interviewee did put an emphasis on issues associated with governance and cross scale linkages. These concepts were very much present when engineering-based mitigation options were assessed through the various claim categories. As such they connected in the stakeholders discourse mitigation option and their assessment. The following thematic categories were thus considered as emerging categories in the course of the analysis:

- “governance”, identifying quotes where the interviewee states that governance plays a role in risk management and;
- “interlinkages” identifying quotes where the interviewee states the questions of cross scale linkages play a role in flood and erosion risk management.

The association of the various themes was explored in site-specific corpus separately, and then across corpuses.

4. Results and discussions

In our corpuses stakeholders did express themselves about engineered solutions. Dykes, drainage systems, breakwater, warning systems, nourishment, floodgates and artificial dunes were all mentioned and contextualized. As mitigation options, within a SPRC worldview, these are not contested. Yet interviewees do express reservations in terms of their implementation, this in the light of their experience. We present these reservations along issues of norms, relevance and evidence.

On the normative front, we see one main issue emerging from the stakeholders discourse. The issue of the redistributive effect of dykes, breakwaters and nourishment is often stressed as an important weakness of these options. In the case of dykes along estuaries, most stakeholders express the fact that dykes, while protecting pre-identified assets, displace the flood elsewhere. They see dykes as a mean to sacrifice areas less close to the interest of politicians. Farmers are sacrificed in the favour of city dwellers. SMEs are sacrificed in favour of large industries. This leads to distrust of dykes and more generally toward mitigation options that displace the risk spatially. Dykes are thus framed as instruments of power and while their performance is somehow recognized, their legitimacy is strongly criticized. Breakwaters, and to a lesser extent nourishment, particularly in areas of high beach usage, is seen as having the potential to redistribute erosion by modifying sediment transfers. Some stakeholders see beach nourishment as a transfer of ecological wealth if sand is brought form productive ecosystems. Finally, in one instance, the issue of ownership of protection structures, and the associated burden of taking care of the structure, was raised as a hidden way of further impoverishing those at risk.
In terms of relevance, stakeholders raised the issue of costs and benefits. The issue raised was that of the difficulty of scaling correctly the cost and benefits. They saw dykes, breakwaters, and floodplains as major investments well beyond the value of what is directly protected. This leads to stakeholders expressing that areas protected by dykes are clearly “overprotected”, thus contesting the pertinence of the option. When explaining this perceived non-pertinence, stakeholders expressed that these choices were governed by nested multi scale economic and political interest leading to choices that seemed not attuned to reality.

Evidence claims were the richest part of the corpus when focusing on engineering-based coastal risk mitigation options. This emerged rather paradoxically as these corporuses, when analysed in more general terms, are clearly dominated by normative claims (see Kane et al., 2014 in this volume). Evidence claims associated with engineering-based mitigation options dealt primarily with governance (or more precisely lack thereof) leading to failures of the options implemented. From dykes left in disrepair, to poorly planned nourishments, or poorly stabilized artificial sand dunes, stakeholders expressed that what mattered was the ability to take care of the mitigation option, not the choice of the option itself. A second type of evidence claim was found in the corpus. These dealt with the importance of seeing the coastal system as a collection of nested, strongly interlinked, subsystems. Stakeholders expressed that dykes, breakwaters, nourished beaches, and artificial dunes faced the influence of distant factors and were influencing other systems. Yet stakeholders expressed that these mitigation options did not seem to take these influences into account in their design. Stakeholders attributed this to a lack of higher order coordination, as a misplaced implementation of subsidiarity. Again stakeholders pointed to a governance deficit. Finally, and this very much in the light of climate change, stakeholders felt that the calibration of engineering-based solutions, was questionable.

If we revisit our working hypotheses in the light of these results, we can safely argue that norms, pertinence, and evidence do influence stakeholders’ attitudes toward engineering-based coastal risk mitigation. Yet this attitude is closely associated with the issue of governance, as the ability to engage into coordinated action, and is thus more broadly defined. What appears is that mitigation, as a technique, cannot, for those affected, be disconnected from the route taken to conduct collective choices. This result seems to point to something more fundamental. Engineering-based mitigation options are clearly efficient when framed in a SPRC worldview, where causal chains are clearly established. Yet stakeholders, when questioning these mitigation options, are talking about boundary conditions – conditions at the boundary of the system or outside these boundaries – (such as externally defined efficient governance), about interconnectedness (distant influence, nested system) and values. It seems therefore that the interviewees displace the discourse within a complex system paradigm, a paradigm where causality is difficult, impossible often, to establish, a paradigm where the future is irreducibly uncertain.

5. Conclusion

In this paper we have analysed how the attitudes of stakeholders toward engineering-based mitigation options was defined. Through an empirical analysis, involving of corporuses generated through interviews in three different settings we showed that norms, pertinence and evidence influence stakeholders’ perceptions of engineering-based coastal risk mitigation options. Furthermore we demonstrated that stakeholders, when envisioning coastal risk mitigation position themselves within a complex system paradigm. The central result points to the need for engineering-based coastal risk mitigation options to be developed with strong multiscale governance mechanisms in place. Without this condition, stakeholders point to weaknesses that cannot be corrected by envisioning the “technique” alone.

These results, while enlightening, call for further developments. First, coastal risk mitigation is a field rich with innovation. Yet our corpus deals only with well-known mitigation options. The real world development of innovative measures should ideally be accompanied with perception and governance analysis in order to guarantee a complete assessment of the option’s value for those affected. Second, our framework could and should be refined by testing it, and the associated results in other settings.

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