The Effects of the Consultation With Residents on the Prevention of Industrial Risks

Nicolas Piluso
Toulouse University Paul Sabatier

Clément Rau
Toulouse University Paul Sabatier

This article models the collaboration between high-risk (hazardous) industries and residents on the safety investments to be implemented. We compare the safety investments level implemented by the company when it decides alone and when there is consultation with residents within the CSS (COMISSION DE SUIVI DES SITES or Site Monitoring Commissions). It appears that companies are likely to increase their investment effort when they consult with the residents. However, although this collaboration with citizens still seems insufficient in the eyes of residents' associations, the consideration of citizen's point of view via a review of accident probabilities does not necessarily have a favorable impact on safety investments. That is why it is necessary to go beyond the limits imposed by the probabilistic approach.

Keywords: industrial risk, consultation, safety investments, risk studies

KEY POINTS

- Taking into consideration the residents' point of view is likely to increase the efforts of SEVESO-classified industries, in terms of safety investment.
- However, the review of risk studies does not necessarily imply a strengthening of securitization processes.
- A real consultation with the residents of an industrial basin could thus involve the consideration of events that are missed by the traditional probabilistic approach.

INTRODUCTION

Over the past 30 years, the theme of major technological risks has been subject to a change in the forms of state intervention but also in the modes of citizen participation.

During this period, public regulations have been built around the idea of obliging so-called SEVESO companies to produce and disseminate data information concerning the risks to which populations living near hazardous establishments may be exposed.

The 2001 disaster at the AZF plant in Toulouse prompted the Government to restructure its major risk prevention policy. This is how the Local Information and Consultation Committee" (LICC) and the Technological Risk Prevention Plans (TRPP) were created with the Bachelot law. The TRPP are planning

documents aimed at reorienting urbanization by taking into consideration the danger zones; the LICC for their part, institutionalize public consultation on the topic of major technological risks. The latter, which have since 2012 been called Site Monitoring Commissions (SMC), have as their main mission the implementation of technological risk prevention plans.

The initial objective of the local information and consultation committee (LICC) is therefore to create spaces for the consultation of the population on the conditions for maintaining a hazardous establishment in an urbanized area. About 500 LICCs have been created, each committee corresponding to the existence of a so-called SEVESO establishment in an urban area (with a few exceptions where SMC groupings have been made due to the proximity of industrial establishments). The permanent secretariats for the prevention of industrial pollution created thirty years earlier made it possible to experiment the principle of consultations. Through the LICC, as Suraud (2013) pointed out, citizens "have access to industrial files and, more specifically, to risks studies carried out by the company"[1]. The risks studies, carried out by industrialists and validated by the public administration, present the sources of the hazard, the potentially impacted areas and the adopted preventive measures. Martinais (2010) pointed out that these studies have become indispensable because they serve as an information tool (i.e they provide important elements for arbitration between the interests of the industrial firm and the interests related to the safety of the residents), and a regulatory tool (i.e. they are the framework for an agreement between the public authorities and industrialists on risk analysis).

The objective of consultation is clear: it is all about informing the citizen, as well as taking into consideration his or her point of view in order to reduce the risks and thus their questionable nature. According to Fiorino (1989), participation (wherein consultation is a special form; with information, consultation and co-decision) is justified by three main series of arguments. Firstly, participation makes it possible to avoid costly questioning of the implemented projects and to mitigate conflicts through a process of social learning (instrumental justification). Secondly, it improves the quality of decision-making through the contribution of multiple knowledge (substantial justification); thirdly, it makes it possible to consolidate democracy and citizenship (normative justification).

The purpose of this article is twofold. It is:

- on the one hand, to evaluate the functioning of the SMC, based on a brief review of the literature,
- but also, and above all, to try modelling the consultation based on the implementation of safety investments in order to determine whether a deepening of this form of public participation or a modification of its modalities would be desirable.

From this perspective, the aim of our research is twofold: do SMC really offer a breakthrough in the integration process from the citizen's point of view? What are the possible economic effects of a deepening of consultation, vis-à-vis a greater consideration of the citizen's point of view?

The basic model in the literature review on civil liability highlights an economic agent whose activity may cause an accident and damage to another agent. However, by its level of effort, it can reduce the probability of the occurrence of an accident. Moreover, the agent cannot escape liability for two reasons. Firstly, the agent has the financial capacity to compensate the victims in case of an accident; secondly, the information concerning the level of prevention of the person responsible and the legal standard that is determined ex post by the court is perfect (Kambia-chopin, 2007). If all these assumptions are adopted, the rules of fault-based liability and no-fault liability are compared in terms of their capacity to generate sufficient incentives for prevention on the part of the potentially liable economic agent. Since the social objective is to minimize the social cost of the agent's activity, the socially optimal effort is that which minimizes the sum of the cost of prevention and the expected damage (Calabresi, 1970; Deffains, 2000; Kambia-Chopin, 2007). The problema of our article is significantly different: here it is a question of analyzing the potential impact of consultation with citizens (potential victims) on the industrial sector's efforts towards risk reduction.

In the first section, we will make a brief review of the sociological literature concerning the operation of the SMC. In a second section, we will present the (simplifying) hypotheses and foundations of our consultation model. In a third section, we will present a first model that makes it possible to highlight the optimal level of safety investment when the firm decides alone. In a fourth and final section, we will

present the consultation model as such, as to compare the investment levels decided in alone or in consultation. We will then analyze the impact of a reassessment of the risk study on the optimal security investment. Based on the latter model, we will discuss whether it would be appropriate to deepen consultation within the SMC or to change its modalities.

WHAT DOES SOCIOLOGICAL LITERATURE REVIEW SAY ABOUT THE CSS OPERATION'S RESULTS?

The Anglo-Saxon literature on the topic of citizen participation (in the general sense of the term) highlights a weariness and disenchantment (Reed, 2008) with the disappointing results obtained. Observation of these participatory arrangements shows that what is expected only occurs to a small extent (Rui, 2010). The democratization of the decision-making process has not really taken place (Bherer, 2011). According to Barbier and Larrue (2011), the benefits of participation on the environment are almost zero, while power asymmetries between actors are not reduced. These harsh conclusions are confirmed in the article by Blondiaux and Fourniau (2011) entitled "A review of the research on public participation in democracy: much ado about nothing? ». How can this failure be explained in concrete terms? Several arguments have been brought up from the literature review. Zwarterook (2010) points out that the various protagonists in the consultation process do not speak the same language and that, because of the asymmetry of position among the actors, we tend to observe a juxtaposition of arguments rather than an integration. We can also mention the complexity of the data to be processed, which tends to distance certain citizens (employees, associations, residents) who are less versed with the issue than other actors such as administrative officials, local elected officials or union delegates (Suraud, 2013). Finally, the lack of citizen mobilization is often bemoaned (Martinais, 2010). Magali Nonjon (2009) studied the actual course of consultation within the CSS and underlined that residents are thus only invited to take on the status of complainants around very factual claims. The legitimacy of proximity then condemns them to remain in the position of simple receivers of information and annihilates any desire for debate.

Grimbo (2013) conducted a field survey on the implementation of TRPP in the Dunkirk territory and the functioning of the SMC associated with them. It appears that residents only perceived the SMC as chambers for recording decisions that had already been taken. One of the main reasons for this observation is that the SMC are only one stage among others in the process of drawing up a TRPP and that the weight of the residents' perspective is particularly weakened. Taking the example of the TRPP of the industrial zone of Dunkirk, the authors showed that residents and employees represented 1/105 of the vote against 46/105 for industrialists and 41/105 for local authorities.

Marie-Gabrielle Suraud (2009), for her part, conducted a field study in the Marseille sector and highlighted more "positive" results. We can generally encounter integration difficulties from the citizen's perspective. The author pointed out the following reasons: "(a) the State and the industrialists retain control of the procedures, especially in the preparation of PPRT, given the high level of expertise required; (b) representatives of civil society are not very involved in these consultation structures and do not recognize them as being capable of having a real influence on decisions, rather preferring, when they have the chance, other debate forums; (c) Lack of time and resources is often the cause of a major difficulty; (d) Elected officials tend to resist these frameworks and question the legitimacy of the positions emanating from LICC". Nevertheless, it appears that in some cases, the residents can influence the decisions taken by the industrialists and public authorities because he or she is a "disruptor" in the negotiations between the decision-makers. "Negotiations between the different components of the decision-making spheres are inflected, transformed by the public eye and by the constraint of public justification of projects" (Suraud, 2009). After the AZF accident, "the advent of the accident materialized the risk and made the danger visible, making risk managers use social pressure as a leverage to strengthen participation. It therefore becomes the industrialist's best interest to get involved in the consultation process. The context momentarily allows an institutionalized body such as the LICC to strongly mobilize all stakeholders" (Suraud, 2009). The authors also showed that consultation modifies the residents' perception of risk and industrial activity towards a more favorable direction.

This brief assessment gives rise to the prospect of examining the potential effects of consultation within the SMC on safety investments and the interest that the various stakeholders (particularly the industrialists and residents) could derive from taking greater considerations of the residents' perspectives.

To answer these questions, we will begin by setting out the hypothesis of the model and theoretically formalize the determination of the level of safety investment to be implemented when the industry decides alone. The result obtained can be compared to a situation wherein residents are involved in the decision-making process.

BASES AND HYPOTHESES OF THE CONSULTATION MODEL

To our knowledge, the article by Piluso and Rau (2016) is the first to model this type of consultation on technological risks. This type of consultation theorizes citizen consultation on industrial risks within the SMC in the form of a negotiation on the safety investment level to be implemented, in order to prevent the occurrence of a risk. Our article will therefore take up the analytical approach and certain hypotheses adopted. This research, published in 2016, shows that an excess of safety investment is, under certain conditions, compatible with a higher expected profit rate. It also shows that a counter-assessment leading to a downward reassessment of the efficiency of safety investments has ambiguous effects on the company's expected profit rate. However, the article does not consider the cost that could ensue from an industrial accident, nor the fact that a safety investment may not only reduce the probability of an accident but also the extent of damage in the event of a disaster.

Of the five hypotheses adopted in the modelling of Piluso and Rau (2016)[1], we have retained four and adopt an alternative hypothesis. The common hypothesis are as follows:

H1. *The company's debt ratio is zero. We assume that the company self-finances its safety investments.*

H2. *The residents fear the threat to which they are exposed and want to reduce this threat by influencing the implementation of the prevention policy by the industrialists.*

H3. *Since in this article, we are looking at major industrial risks, we've assumed that the occurrence of an accident prevents the company from carrying out its productive activity (partial or complete destruction of the productive apparatus). Consequently, any profit realized by the company implies that no major accidents have occurred.*

H4. *We exclude any problem of insolvency from the company.*

The hypothesis that makes our work different is the following:

H5. *Safety investments does not only affect the probability of an accident occurring, but also the magnitude of damage in the event of the materialization of a risk. The extent of the damage determines at least in part, the amount in compensation to be paid by the company to the residents.*

Modeling the Company's Behavior

The net profit π of the firm investing in safety is defined by the equation:

$$\pi = g - x \tag{1}$$

where g is the company's gross profit and x is the amount allocated for the safety investment in the period under consideration.

It is particularly difficult to specify an accident probability function. This one results most often from the empirical studies on the frequency of occurrences which are exogenous (Levêque, 2013, Gollier,

2007). Moreover, it can be modified depending on the experts who are commissioned. In other words, by definition, there is no microeconomic basis for establishing such a function. However, for a theoretical work of comparing the "performance" of a public policy (in relation to a reference, which is generally the first best - benevolent dictator), having a precisely specified function is not necessary. The comparison of first-order conditions is enough to judge the possible suboptimality of an equation.

We will therefore adopt the same accident probability function as in the article by Piluso and Rau (2016):

$$\varphi(x) = 1/ax \tag{2}$$

This function therefore decreases with an increase in the safety investment implemented[1]. The parameter *a* represents the degree of efficiency of the safety investment, or, equivalently, the degree of dangerousness of the installation once the investment has been put in place. When *a* increases, the same level of safety investment will results in a lower probability of an accident. The higher the parameter, the more effective the investment is, or, in other words, the installation will be considered as being less dangerous. This parameter is estimated by internal expertise services within the company and is made public by the report showcasing the risk study.

Similarly, the cost of damages function, in the event of an accident, is decreasing and equally depends on the rate of safety investment. Indeed, the greater the safety effort, the less the significance of the damage in the event of an accident:

$$C(x) = C/ax \tag{3}$$

with *C* being a parameter greater than zero.

The manager's objective is to maximize the net profit expectation:

$$\omega = (g-x)(1-1/ax) - (C/ax)(1/ax) \tag{4}$$

The net profit *(g-x)* is obtained if there is no accident (with a probability of *1-1/ax*); the costs related to the damage are borne by the company if an accident occurs (with a probability of *1/ax*)[1].

This modelling of managerial behavior is in line with the tradition of risk modelling derived by Farmer (1977) and the ALARP (*As Low As Reasonably Practicable*) approach. Farmer (1977) highlighted a decreasing statistical relationship between the frequency of an accident and its severity. Three risk zones were then identified: an intolerable risk zone due to very high frequency or severity, a low risk zone (very low probability or limited consequences of an accident) and finally an intermediate risk zone. Industrial installations presenting a technological risk are most often considered to belong to the intermediate risk zone. Within the intermediate risk zone, industrialists find themselves stuck between increasing the costs of providing additional safety facilities and the reduction of risks associated with these facilities. In this so-called ALARP approach, the industrialist must determine the level of safety investment that minimizes its cost function (or, equivalently, maximizes its profit function), knowing that, as Barro (2006) showed, the occurrence of an accident alters the firm's profitability.

Our modeling is also in line with the article by Ehrlich and Becker (1972), which shows that firms seek to reduce the random dimension of their economic performance through several types of expenditure: self-protection, self-insurance and insurance expenses. In our analytic framework, self-protection expenses include measures implemented to reduce the probability of accidents (see our accident probability function); self-insurance expenses refer to the search for cost containment in the event of the materialization of a risk (see our damage cost function). The safety investments discussed in our analysis refer to self-protection and self-insurance as was seen in the article by Ehrlich and Becker (1972). For the sake of simplicity, however, we neglect insurance expenses.

Modeling the Behavior of Residents

The utility function which we are modeling is based on the theoretical analysis of Piluso and Rau (2016). They emphasized that "according to sociologists, there is a perception asymmetry between industrialists and residents, in other words, between those who produce the risk and those who are involuntarily exposed to it: the industrialists carry out a cost-benefit calculation of the facilities on the basis of probabilities of occurrence, whereas residents only perceive the danger represented by the existence of these facilities independently of any probability of occurrence (Chaskiel, 2008). Residents do not make any critical assessment on the threat (or potential loss) associated with the facility. Especially with regards to the threat with "long-developing time", they express a fear of its propagative nature and its capacity to have consequences on future generations. In the shorter term, from a material perspective, residents fear the threat to their homes, which is most often acquired over the long term. It is thus assumed that the residents want to ward off this threat by weighing on the implementation of prevention policies by industrialists" (Piluso and Rau, 2016, p. 64).

It is thus assumed that the residents' interest is described by an expected payment function that depends positively on the quantity of good S^2 produced by the firm (the price of the good is assumed to be per unit), and negatively on the cost of damage (net of the collection of compensation) in the event of the occurrence of a risk. This payment function is written thus:

$$U = S(1-1/ax) - D(x)(1/ax) \tag{5}$$

With *D(x)* being the cost of damage function, which residents are likely to bear with the probability of an accident *(1/ax)*. *D(x)* is written as follows:

$$D(x) = D/ax \text{ with D>0.} \tag{6}$$

The function *D(x)* shows that an increase in the company's effort in terms of safety investment will reduce the potential net damage that the resident would have to suffer in the event of an accident.

This modeling is of course simplifying. The supposed homogeneity of the residents constitutes a limitation in the model we are proposing. Not all the residents necessarily advocate for a greater safety. Citizens will also want fewer constraints from the public authorities or will not want to have work imposed on them; just to take this example alone. However, the empirical work which we mentioned in the first part of the article shows that residents are generally in favor of preventive and precautionary measures taken by industry and public authorities.

THE MODEL WITHOUT CONSULTATION: THE DETERMINATION OF THE SAFETY INVESTMENT RATE OF THE COMPANY DECIDING ALONE

In the absence of any citizen consultation, the company may seek to maximize its profit expectations. We write the program as follows:

$$\begin{aligned} &Max\ (g-x)(1-1/ax) - (C/ax)(1/ax) \\ &x \geq 0 \end{aligned} \tag{7}$$

with $(g-x)(1-1/ax)$ representing the profit realized by the company when no accident occurs, while $(C/ax)(1/ax)$ represents the cost of damages suffered by the industrialist when a risk materializes.

The expression is maximized with respect to the variable x when its first derivative is equal to zero (first-order condition). This gives:

$$-1+\frac{g}{ax^2}+\frac{2C}{a^2x^3}=0 \tag{8}$$

That is $f(x)=-1+\frac{g}{ax^2}+\frac{2C}{a^2x^3}=0$.

With F being the sum of three functions decreasing by $\Re_+^*$, therefore f is exclusively decreasing. Moreover, this function is continuous on $\Re_+^*$. Consequently, by the intermediate value theorem, we have x_1^* such that $f'(x_1^*)=0$.

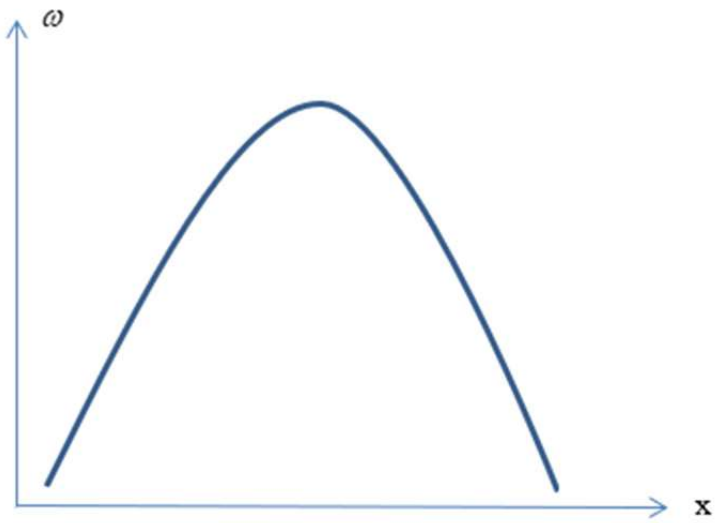
x_1^* is therefore the security investment that maximizes the expected net profit. The explicit solution is given by:

$$x_1^*=\frac{ag}{\sqrt[3]{3}\sqrt[3]{9a^4c+\sqrt{3}\sqrt{27a^8c^2-a^9g^3}}}+\frac{\sqrt[3]{9a^4c+\sqrt{3}\sqrt{27a^8c^2-a^9g^3}}}{3^{2/3}a^2} \tag{9}$$

with $a\neq 0$ $\frac{ag}{\sqrt[3]{3}\sqrt[3]{9a^4c+\sqrt{3}\sqrt{27a^8c^2-a^9g^3}}}+\frac{\sqrt[3]{9a^4c+\sqrt{3}\sqrt{27a^8c^2-a^9g^3}}}{3^{2/3}a^2}\neq 0$.

The expected net profit function has a bell-shape:

FIGURE 1



In other words, during the first phase of the increase in safety investment (within the range $[0;\frac{ag}{\sqrt[3]{3}\sqrt[3]{9a^4c+\sqrt{3}\sqrt{27a^8c^2-a^9g^3}}}+\frac{\sqrt[3]{9a^4c+\sqrt{3}\sqrt{27a^8c^2-a^9g^3}}}{3^{2/3}a^2}]$, the company and residents

interests seem to converge, since any increase in safety investment increases the manufacturer's expected net profit and the expected payment to the residents (the latter being an increasing function of the safety investment rate for positive values of this rate). However, the probability function of the occurrence of a risk implies that beyond a certain amount invested, the cost of an additional investment outweighs the benefit to the firm in terms of risk reduction. The traditional economic literature also shows that as the investment increases, its marginal cost increases (an idea found, for example, in Keynes' hypothesis of decreasing marginal efficiency of capital).

The first result emanating from this analysis therefore shows that there may be a convergence between the interests of residents and those of industrialists in terms of securing facilities.

THE MODEL WITH CONSULTATION

Consultation between companies and residents in the context of Site Monitoring Commissions (SMC) does not refer to an actual negotiation, in the strict term of the word, but rather the taking into considerations of the worries of agents exposed to the risk. The consultation model will therefore take the standpoint of maximizing collective well-being. Let us assume a collective payment function *W*, to be the sum of the expected profit function and the payment to residents' function (with reference to Bator's (1957) work on maximizing *social welfare*).

$$W = \omega + U \tag{10}$$

The consultation therefore consists of maximizing this collective payment function:

$$\begin{aligned} &Max\, W = \left[(g-x)(1-1/ax)-(C/ax)(1/ax)\right]+\left[S(1-1/ax)-D(x)(1/ax)\right] \\ &x \geq 0 \end{aligned} \tag{11}$$

This function is collective since it simultaneously takes into consideration the expected profit of the industrialist (under the expression $\left[(g-x)(1-1/ax)-(C/ax)(1/ax)\right]$ already explained above) but also the expected utility of the residents (represented by the expression $\left[S(1-1/ax)-D(x)(1/ax)\right]$).

The first-order condition gives:

$$f(x)+\frac{aSx+2D}{a^2x^3}=0 \tag{12}$$

By the same argument as in paragraph II, there is a safety investment rate x_2^* that satisfies the first-order condition. Consequently, x_2^* is the safety investment that maximizes the collective welfare function. The explicit solution is given by:

$$x_2^* = \frac{\sqrt[3]{54a^4c+54a^4d+\sqrt{(54a^4c+54a^4D)^2+4(-3a^3g-3a^3S)^3}}}{3\sqrt[3]{2}a^2} - \frac{\sqrt[3]{2}(-3a^3g-3a^3S)}{3a^2\sqrt[3]{(54a^4c+54a^4D+\sqrt{(54a^4c+54a^4D)^2+4(-3a^3g-3a^3S)^3}}} \tag{13}$$

with $a \neq 0$ and

$$\frac{\sqrt[3]{54a^4c+54a^4d+\sqrt{(54a^4c+54a^4D)^2+4(-3a^3g-3a^3S)^3}}}{3\sqrt[3]{2}a^2} - \frac{\sqrt[3]{2}(-3a^3g-3a^3S)}{3a^2\sqrt[3]{(54a^4c+54a^4D+\sqrt{(54a^4c+54a^4D)^2+4(-3a^3g-3a^3S)^3}}} \neq 0 \tag{14}$$

This thus generates the question as to whether the investment resulting from consultation is higher or lower than that from a company deciding alone.

It is possible to show that the safety investment rate resulting from the maximization of collective well-being x_2^* is greater than or equal to that when a company is deciding alone x_1^*.

Let us absurdly assume that $x_1^* > x_2^*$. we can logically deduce that $f(x_2^*) > 0$ by exclusively decreasing f. We therefore have:

$$f(x_2^*) + \frac{aSx_2^* + 2D}{a^2 x_2^{*3}} > 0.$$

This is absurd by the definition of x_2^{*3}.

Consultation Within the SMC Therefore Theoretically Brings Progress in Terms of Industrial Safety Since It Can Be Accompanied by an Increase in the Safety Investment Rate Implemented by the Company.

This has already been demonstrated in other contexts. Consultation leads the company to integrate the objective function of the residents. This function increases with the safety investment level. By including the residents' well-being, additional benefits are added to the safety investment decision. Here, it is all about the classic internalization result of a positive externality: investment in safety allows the company to reduce the expected prospect of paying damages (C/ax), but also reduces the damage to the residents. Without consultation, this benefit to the residents is not internalized. There is a problem of underproduction of safety investment. Through consultation, this benefit to residents is internalized: the firm thus produces more safety investment.

This admittedly classic result deserved to be highlighted in the "new" context of the consideration by industrialists of the residents' perspective. In the case of civil liability, it is the prospect of payment in the event of an accident that makes it possible to internalize the externality in the company's objective function. In the case of Pigouvian taxation, it is the payment of the (unitary) tax that forces the company to take into consideration its externality (see Kambia-Chopin cited on page 2-3 for the explanation of this rationale). However, what will it be like when there is consultation? By what mechanism is the company "forced" to take into consideration the well-being of the residents? In fact, there are no financial or penal sanctions, nor is there a threat of a reduction in demand from consumers that would allow for internalization in the company's program. At the end of the consultation process, the company is therefore perfectly free to take the residents perspective into consideration or not. We have, however, seen in section 1 that in the case of the SMC in Dunkirk, the AZF disaster created a climate that favored the convergence of the interests of both the residents and industrialists, the latter being more inclined to implement a more secure framework for their activities.

There are several methods of deepening consultation with residents. Our model makes it possible to analyze one example from the many deepening methods. Let us suppose, for example, that residents' associations have the possibility of demanding a counter-assessment and that this counter-assessment results in a lower efficiency in safety investments than the first assessment. What will be the consequence vis-à-vis the safety investments made?

In the model without consultation, let us take the function $a \to x_1^*(a)$. It is continuous on $]0;+\infty[$

Indeed, either $F(x,a) = gax - a^2x^3 + 2C$ (numerator of the first-order condition).

x_1^* verify that $F(x_1^*, a) = 0$

$$\frac{\partial F}{\partial x} = ga - 3a^2x^2$$

$$\left(\frac{\partial F}{\partial x}\right)_{x_1^*(a),a} = ga - 3a^2(x_1^*(a))^2 = -2a^2(x_1^*(a))^2 - \frac{2C}{x_1^*(a)}$$

since $ga = a^2x_1^2 - 2C/x_1$.

By the implicit function theorem, there is value close to *a* for which x_1^* is continuous and

$x_1'(a) = \dfrac{\partial F/\partial a}{\partial F/\partial x}$:

$$\left[\frac{\partial F}{\partial a}\right]_{x_1,a} = gx_1 - 2ax_1^3 = -a(x_1^*)^3 - 2C/a.$$

Where $x_1'(a) = -\dfrac{-a(x_1)^3 - 2C/a}{-2a^2(x_1)^2 - \dfrac{2C}{x_1}} > 0.$

Therefore $a \to x_1^*(a)$ increases by a.

In the model with consultation, we prove by the same argument that $x_2(a)$ is differentiable in *a*.

$x_2'(a) = \dfrac{\partial G/\partial a}{\partial G/\partial x}$ where $G(x,a) = -a^2x^3 + gax + 2C + aSx + 2D$ (numerator of the first-order condition).

$$x_2'(a) = \frac{-2ax_2^3 + gx_2 + Sx_2}{-3a^2x_2^2 + ga + aS} = -\frac{-ax_2^3 - 2\dfrac{C+D}{a}}{-2a^2x_2^2 - 2\dfrac{C+D}{x_2}} \geq 0$$

Knowing that $G(x_2(a);a) = 0$.

The function $a \to x_2^*(a)$ increases with a.

If a Counter-Assessment Shows That the Efficiency of the Safety Investments Is Lower, Then the Company Will Be Encouraged to Decrease the Safety Investment Rate Instead of Increasing It, Both in the Event Where the Counter-Assessment Was Done Alone or With the Consultation of the Residents.

Indeed, the marginal cost of safety is -1 (since the total cost is -X). The marginal benefit of safety is to reduce the company's expected payment in damages (if we consider the case without consultation; with consultation, we need to add the benefit in terms of the reduction in expected damage payment to the residents and the increase in the probability of enjoying, S). If safety is less efficient, then the marginal benefit of safety is reduced (i.e. it is more difficult, by increasing x, to reduce the probability of an accident / prospect of paying damages) while the marginal cost remains unchanged (because it is independent of the efficiency "a" of the safety effort): it is perfectly obvious that the level of safety

decided at equilibrium is reduced. This classical reasoning can thus be applied to this new context of consultation and counter-assessment.

It should also be stressed that this result is due to the functional form of the probability of an accident. That is, to vary both the level of probability (at a given level, x) and the marginal efficiency of x. If the accident probability takes an affine functional form such as:

$$\varphi(x) = a + (0.5/x) \tag{15}$$

with $a < 0{,}5$, therefore an increase in a (here, we must consider an increase) will lead to a higher probability (at the given x) but does not affect the equilibrium x. So, it is in fact a change in the marginal efficiency, not the overall efficiency, of the safety investment that can yield our result. The above conclusion only applies for some technologies, where the marginal efficiency of the safety effort can be changed. If we extend this reasoning to technologies whose marginal safety efficiency cannot be modified, then deepening the consultation via the possibility for citizens to mandate a counter-assessment would not lead to any change in the company's decision.

Without any doubt, the development of citizen consultation can be a vector for the development of a territory. According to Gay and Picard (2001), the "residing, organized territory, where power, strategy and trust can be expressed, presents an ideal configuration for the emergence of innovation activities by serving as a catalyst for the interactions that generate them. [...] *Last but not least*, the innovative capacity attached to the territory makes it a privileged instrument of endogenous development that justifies its mobilization in public action". According to Blanchet and Paquiet (1999), the actors of a territory allow for a better control of the environmental consequences of the economic activity of high-risk (hazardous) industries if they are endowed with a real capacity to influence. They can even become, according to the same authors, the key component of a true development project. Finally, according to Blanchet, Paquiet, Zampa (1996), "the presence of chemical industries is an asset that an agglomeration must be able to develop. To do this, it is necessary to consult each other more and more to resolve conflicting points in terms of the environment and risk". However, we are trying to emphasize here that the impact of deepened consultation from a strictly safety perspective is likely to remain ineffective.

Let us, however, note that the probabilistic approach adopted within the CSS and which we have used for the model in this article does not deal with responses to the consequences of events qualified as improbable.

Chaskiel (2008) and Piluso (2013) pointed out that, when an industrial disaster such as Fukushima occurs, the residents rally around the concept of the danger. The danger can be defined in the potential disaster to which the residents are exposed because of a decision by industrialists that was imposed on them. The residents thus reject the probabilistic calculation and focus on the evaluation of the potential damage that an industrial installation may cause. In this perspective, nothing justifies the existence of a dangerous installation, but the decision rests on the shoulders of the industrialists and the public authorities. The traditional distinction between risk and uncertainty is eclipsed in favor of the distinction between risk (which is dependent of the industrialists' approach) and danger (which is dependent of the residents' approach). Spangler (1982) emphasized under this perspective that the assessment criteria for high-risk (hazardous) industrial installations are likely to diverge greatly.

The probabilistic approach thus contributes to biasing the debate between specialists on the one hand, and between specialists and citizens on the other. Within the framework of the preparation of risk studies, the work of sorting out dangerous phenomena and the selection of events likely to contribute to the dimensioning of safety investments are influenced by the traditional ALARP approach explained above. The most dangerous events, because they are highly unlikely, are frequently excluded from the risk studies. Accidents with slow kinetics are also excluded, on the grounds that it is possible to evacuate populations, thus saving them (Martinais, 2010). The more numerous the eligible phenomena are, the higher the estimated level of dangerousness of the industrial installation. One of the ways to improve consultation and therefore safety would be to involve the residents in the discussion on eligible events.

Our model shows in this respect that such a deepening of consultation, if it leads to more safety investment, can be compatible with an increase in the expected profit.

More generally, the avenues for improving citizen consultation on technological risks can be inspired from Beierle's (1999) reading grid, which proposes a list of socially desirable effects of taking the citizen's perspective into consideration: educating the public, incorporating public interests into the decision-making process, improving the quality of decisions, strengthening confidence in institutions, reducing conflicts and, finally, justifying the time devoted to citizen participation. Webler, Tuler and Krueger (2001) stressed the need to neutralize power asymmetries between actors, which is in line with our proposal to take into consideration the citizen's perspective by going beyond the limits imposed by the probabilistic approach. This perspective is also in line with that of Viscusi (2000), who emphasized that a probabilistic cost-benefit analysis may not be enough to adopt sufficiently protective measures: « Indeed, we want corporations to think about risks in a systematic manner and to undertake such calculations to ensure that there is appropriate risk balancing that is sufficiently protective. We all benefit when corporations have selected the right level of safety that is reflective of our own concern with safety and the costs of providing it. The merits of the analysis and the ultimate balance struck should be the main manner of concern, not whether undertaking a systematic analysis allegedly reflects a cold-blooded attitude towards human life. Of course, the fact that companies have undertaken such balancing does not imply that they should be vindicated on economic grounds. Even armed with an extensive risk analysis, companies may fail to make sufficiently protective decisions. However, liability for corporate behavior should hinge on the risk and cost decisions, not on whether the firm undertook a risk analysis. We want to encourage corporations to do such systematic thinking about risk and cost » (Viscusi, 2000, p.4).

CONCLUSION AND RECOMMENDATION

The model presented in this article describes the decision-making process of high-risk industries in terms of safety investment. It shows that, with the establishment of bodies for consultation with the local population, companies may be led (in an uncertain manner) to invest more in safety. However, an increase in the estimated probability of an accident, which could be obtained by a counter-assessment, does not necessarily lead to an increase in the safety effort. The idea of a counter-assessment commissioned by the residents' association may therefore prove to be a double-edged sword.

These conclusions drawn from this model only shed light on part of the in-force dynamics in a participation process, wherein the actors must arbitrate between several risks and develop complex relationships. This, however, pertains to a shortcoming specific to many models that lead to a simplification of reality. We are part of the approach initiated by Piluso and Rau in 2016, which aimed at formalizing the impact of taking the citizen's perspective into consideration during risk management.

One of the means we are suggesting towards improving consultation and industrial safety is to involve the residents in the choice of events eligible for the risk study. This involves integrating into the company's decision-making process, the residents worry vis-à-vis the highly dangerous and improbable events, which are usually excluded from analyses based on a probabilistic approach.

ACKNOWLEDGEMENTS

We would like to say a big thank you to Anne Lalo, Senior Lecturer in Sociology at the University of Nice (an expert on the issue of technological risks) for having read this article and for giving her evaluation reports; but also for her precious advice during the review of this article. We also thank Patrick Chaskiel and Marie-Gabrielle Suraud from the Paul Sabatier University of Toulouse, equally experts on the issue of risks, for their advice on the bibliography of the article. The perspectives spelled out in this article, however, come from the authors alone.

Translated and Edited by American Publishing Services

https://americanpublishingservices.com/product/translation/

ENDNOTES

1. On suppose que le régime de responsabilité civile est celui d'une responsabilité sans faute : la firme est toujours responsable (quel que soit x).
2. Le bien en question peut par exemple être un produit de raffinerie utile aux besoins quotidiens de tout consommateur. TO TRANSLATE
3. $1/ax$ représente une probabilité, qui est donc comprise entre 0 et 1. Par conséquent, $x > 1/a$. On doit supposer en amont que $a > \frac{1}{g+2C}$. C'est en effet la condition pour que $f(\frac{1}{a}) > 0$.

REFERENCES

Barbier, R., & Corinne, L. (2011). Démocratie environnementale et territoires : un bilan d'étape. *Participations*, *1*(1), 67-104.

Barro, R. J. (2006). Rare disasters and asset markets in the twentieth century. *The Quarterly Journal of Economics*, *121*(3), 823-866.

Bator, F. (1957). The Simple Analytics of Welfare Maximization. *The American Economic Review*, *47*(1), 22-59

Beierle, T. C. (1999). Using Social Goals to Evaluate Public Participation in Environmental Decisions. *Policy Studies Review*, *16*(3/4), 75-103.

Bherer, L. (2011). Les relations ambiguës entre participation et politiques publiques. *Participations*, *1*(1), 105-133.

Blanchet, P., & Paquiet, P. (1999). Qualité des territoires et performance des entreprises. Démarches territoriales pour un management environnemental. *Revue de géographie de Lyon*, *74*(3), 199-207.

Blanchet, P., Paquiet, P., & Zampa, C. (1996). Industries chimiques et territoires : contraintes et opportunités de développement. *Revue géographique de Lyon*, *71*(1), 23-30.

Blondiaux, L., & Fourniau, J. M. (2011). Un bilan des recherches sur la participation du public en démocratie : beaucoup de bruit pour rien ? *Participations*, *1*(1), 8-35.

Bourg, D., & Boy, D. (2005). *Conférences de citoyens, mode d'emploi*, Ed. Charles Léopold Mayer. Paris.

Calabresi, G. (1970). *The Cost of Accident*. New Haven, Yale University Press.

Callon, M., Lascoumes, P., & Barthe, Y. (2001). *Agir dans un monde incertain. Essai sur la démocratie technique*, Le Seuil, collection « La couleur des idées », Paris.

Chaskiel, P. (2008). Luhmann et le mystère du risque technologique. Un retour de l'opinion publique. *Réseaux*, *151*, 54-70.

Deffains, B. (2000) L'évaluation des règles de droit: un bilan de l'analyse économique de la responsabilité. *Revue d'Économie Politique*, *110*(6), 751-785.

Fiorino, D. (1989). Environmental risk and democratic process: A critical review. *Columbia Journal of Environmental Law*, *14*, 501-547.

Gay, C., & Picard, F. (2001). Innovation, agglomération et espace : une mise en perspective de la littérature. *Économie et Sociétés*, *6*, 679-716.

Gollier, C. (2007). Comment intégrer le risque dans le calcul économique ? *Revue d'économie politique*, *117*(2), 209-223.

Grimbo, N. (2013). PPRT dans les Dunkerquois : des artifices d'une concertation obligée à la construction d'un compromis. *Cahiers de la sécurité Foncsi*, n° 2013-08.

ICSI. (2009). Etudes de danger et ouvertures au publics. *Cahiers de la sécurité industrielle*, *5*(7).

Kambia-chopin, D. (2007). Règles de responsabilité civile et prévention des risques environnementaux. *Revue Economique*, *2*(117), 285-308.

Le risque industriel. (2007). *Dossier informatif*. Ministère de l'Écologie, du Développement et de l'Aménagement durables. Retrieved from https://webcache.googleusercontent.com/search?q=cache:y8ewMENJ3XwJ:https://www.ecologique-solidaire.gouv.fr/sites/default/files/130601_Demarche-francaise-prevention-risques-majeurs_DEF_Web.pdf+&cd=11&hl=fr&ct=clnk&gl=fr

Levêque, F. (2013). *Le risque d'accident nucléaire majeur : calcul et perception des probabités*. Working Paper 13-ME-02. CERNA, Mines, Paris.

Martinais, E. (2010). Les fonctions sociales et politiques de l'étude de dangers dans le domaine des risques industriels. *Géocarrefour*, *85*(4), 293-301.

Nonjon, M. (2009). Ouvrir la concertation sur les risques industriels : quelle place pour les riverains? In M.G. Suraud (dir.), *Risques industriels: quelle ouverture publique?* Octares éditions, Paris.

Piluso, N. (2013). Choix technologiques des firmes et équilibres de consommation contestée. *Revue D'économie Industrielle*, *143*(3), 62-80.

Piluso, N., & Rau, C. (2016). Les investissements de sécurisation des sites industriels à risque et la concertation entre firmes et riverains: une approche théorique. *Région et Développement*, (64), 45-60.

Reber, B. (2011). *La démocratie génétiquement modifiée*. Presses de l'université Laval, Quebec.

Reed, M. (2008). Stakeholder participation for environmental management: A literature review. *Economic Review*, *5*, 205-218.

Revel, M. (2007). *Le débat public : une expérience française de démocratie participative.* La découverte, Paris.

Rui, S. (2010). Les développements de la démocratie participative. *Les Cahiers Français*, *356*, 68-74

Spangler, M. B. (1982). The Role of Interdisciplinary Analysis in Bridging the Gap Between the Technical and Human Sides of Risk Assessment. *Risk Analysis*, *2*(2), 101-114

Suraud, M. G. (2009). La concertation: changements et questions. *Cahiers de la sécurité Foncsi*, 2009-03.

Suraud, M. G. (2013, December). L'espace public des risques : communication et concertation. *Document de travail du Certop.* Toulouse.

Webler, T., Tuler, S., & Krueger, R. (2001) What Is a Good Public Participation Process? Five Perspectives from the Public. *Environmental Management*, *27*(3), 435-450.