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An evaluation of a risk-based environmental regulation in Brazil: Limitations to risk management of hazardous installations

Andre NaimeDr *

Brazilian Institute of the Environment and Renewable Natural Resources, IBAMA, Brazil

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ABSTRACT

The environmental regulation of hazardous projects with risk-based decision-making processes can lead to a deficient management of human exposure to technological hazards. Such an approach for regulation is criticized for simplifying the complexity of decisions involving the economic, social, and environmental aspects of the installation and operation of hazardous facilities in urban areas. Results of a Brazilian case study indicate that oil and gas transmission pipelines may represent a threat to diverse communities if the relationship between such linear projects and human populations is overlooked by regulatory bodies. Results also corroborate known challenges to the implementation of EIA processes and outline limitations to an effective environmental and risk management. Two preliminary topics are discussed to strengthen similar regulatory practices. Firstly, an effective integration between social impact assessment and risk assessment in EIA processes to have a more comprehensive understanding of the social fabric. Secondly, the advancement of traditional management practices for hazardous installations to pursue a strong transition from assessment and evaluation to management and control and to promote an effective interaction between land-use planning and environmental regulation.

1. Introduction

The environmental regulation and decision-making process of hazardous projects are based on comprehensive technical information that encompasses the evaluation of environmental and social impacts and risks. The assessment of risks frequently relies on the outputs of a quantitative risk assessment (QRA). The advantages of QRAs are widely discussed in the literature (Cox, 2002; Smith, 2005) and their application is enforced in diverse countries (McColl et al., 2000; Cozzani et al., 2006; Kirchhoff and Doberstein, 2006).

In a QRA, risk is the anticipated outcome of the interaction between an accident and a human population. Results of a QRA are presented in the form of risk rates (Molak, 1997; HSE, 2008) and express the likelihood of an individual or group of people being killed as the consequence of an abnormal event associated with the operation of an industrial facility or other technological system. Decision makers confront these rates with pre-established standards to evaluate whether is safe to operate such an enterprise near human populations (Kirchsteiger, 2005; Kirchhoff and Doberstein, 2006; Aven, 2007). Usually, if the estimated rates are below a given threshold, the technological project is deemed safe and the undertaking (or any of its stages) is approved. If these numbers are higher than this threshold, the project undergoes a redesign to bring the risk rates down to an acceptable level.

Often referred to as risk-based decision-making process (McColl et al., 2000; Klinke and Renn, 2002; Naime and Andrey, 2013), such an approach for regulation is criticized for lacking a full set of instruments to assess the social fabric (Asveld and Roeser, 2009; Bea et al., 2009) or to accommodate the complexity of decisions involving the economic, social, and environmental aspects of the installation and operation of hazardous facilities in urban areas (Klinke and Renn, 2002; Aven et al., 2007). In risk-based approaches, decisions about exposure and risks mainly consider the inputs from the hazardous project, as if the human system were a static or simplified component in the analysis. The quantification of risks contributes to decision making but this information should not be the only input to the regulatory process. If one seeks to pursue the safety of human populations, an understanding of the social fabric cannot be narrowed down to the sole estimation of numbers and rates.

A major practical implication of such biased regulation, a regulation that tilts the assessment and the decision making towards the inputs provided by an industrial system in detriment to the inputs of a social fabric, is a low effectiveness in the control of human exposure to the hazards of technological installations. In this context, in order to investigate opportunities to promote better regulation and management, this paper explores a Brazilian case study of oil and gas transmission pipelines. It is expected that results would be relevant to similar regulatory practices, providing a thorough review of common limitations to comply with various EIA design and risk governance principles.

* Corresponding author.
E-mail address: andre.naime.ibama@gmail.com.

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The relevance of transmission pipelines systems:

Regulation of oil and gas transmission pipelines projects addresses diverse aspects related to the economic activity, technical details of the project's installation and operation, and an array of social and environmental impacts, which may involve a few regulatory agencies in different governmental levels. In this context, a reasonable degree of integration of governmental bodies is required to assemble a regulatory framework[1] able to oversee the many aspects of the relationship between human populations and these linear projects when they share a common space.

Such a regulation also requires cooperation between the many involved parts in order to ensure safety for human populations (IRGC, 2008). For instance, management practices for transmission pipelines demand considerable efforts from the company operating the pipelines but it also requires specific actions from governmental and non-governmental institutions and local stakeholders. Given that an effective way to avoid people to be affected by risks is preventing them from being exposed to hazards, a particular action to ensure security is promoting a strict supervision of land use in the vicinity of hazardous installations (Seveso, 1996; MIACC, 1998; TRB, 2004). In other words, it is important that a regulatory framework for hazardous projects integrates actions towards the enforcement of a risk management that considers land-use compatibility.

However, integrated regulation is of difficult implementation, especially when the involved institutions are barely able to perform their individual attributions. Lack of qualified staff, technical standards, institutional planning, and resources in general are some common shortcomings of regulatory agencies in many countries (Cashmore et al., 2004). Eventually, the relative low performance of these institutions and the quality of their integration in a country's regulatory framework jeopardize the application of EIA processes.

1.1. Regulation and management of transmission pipelines in Brazil

In Brazil, oil and gas transmission pipelines (OGTP) are laid underground in right-of-ways (ROW), often hundreds of kilometers in length and crossing several municipalities. Unlike most industrial activities, where the boundaries between communities and the facility are relatively restricted, delimited by physical barriers (such as fences and walls), and enforced by municipal by-laws (such as a city master plan), pipelines in urban areas in Brazil have particularities that often encompass: 1) the absence of physical barriers to limit the boundaries of a ROW; 2) the coexistence of pipelines and residential areas in the same space; and 3) the absence of formal provisions in local master plans to acknowledge the risks of the pipelines. It is also worth noting that the urbanization in Brazil often happens with common patterns observed in developing nations (Hardoy and Satterthwaite, 1989): urban development occurring in discordance with civil and environmental legislations and the city master plan, local policies, and codes (Pinto, 2003); suburbs displaying low socioeconomic indexes (Gay, 1994; Szwarcwald et al., 2002); new suburbs being developed in illegal areas (Serra et al., 2004; Paviani, 2007); and a common unplanned urban sprawl (Martine and McGranahan, 2010).

At the Brazilian federal level, the regulation of large OGTP is typically carried out by three regulatory bodies: 1) the Brazilian Institute of Environment and Renewable Resources (also known as IBAMA), which regulates aspects related to environmental impacts and technological risks (Conama, 1986, 1997; Glasson and Salvador, 2000; IBAMA, 2008); 2) the National Agency for Petroleum, Natural Gas, and Biofuel (ANP), which regulates the technical and economic aspect of the transportation activity; and 3) a multitude of municipalities (local governments) that regulate land use in their jurisdictions (Brasil, 2004). Although shared regulation favors specialization, Brazil's regulatory framework is disjointed as these three regulatory bodies fail to integrate agendas to pursue comprehensive and common public policy.

One important drawback of this lack of integration relates to the safety of human populations due to risks imposed by OGTP. Since the project's conceptualization takes place at ANP's regulatory process and the land-use planning is carried out by the municipalities, IBAMA faces an important challenge that is to effectively: 1) implement macro modifications in the pipeline route in the early stages of the environmental regulation to prevent pipelines from interfering with urban areas and 2) implement measures for management of exposure to pipelines' risks later on in the regulatory process (when the pipeline starts up operation) to prevent urban areas from interfering with pipelines. Four examples are chosen for contextualization, albeit replications are found throughout the country in the intersection of OGTPs with all major Brazilian metropolitan areas.

Example 1:

Fig. 1 (from 2001) and Fig. 2 (from 2015) illustrate changes in the urban shape in the Brazilian city of Macaé (state of Rio de Janeiro), coordinates −22.3371 and −41.7790 degrees decimal. Fig. 1 shows an existing pipeline ROW (red line) crossing a rural area as it approaches the district of Planalto da Ajuda in the city of Macáe. A few years later that uninhabited area was allotted for a new urban development, which forced the pipeline operating company to propose an alternative route to avoid the interference with a future human community (light yellow line in Fig. 2). In this example, the local land-use planning failed to acknowledge the pre-existence of the OGTP, since the ROW was prior to the urban development plan. The decision to develop a new neighborhood near the OGTP implied in risks to that future community (at first) and in costs to the transportation activity due to the necessity to establish a new ROW (in a second moment).

Example 2:

Fig. 3 shows a community between coordinates −23.65950, −45.43956 and −23.66149, −45.45046 (degrees decimal), in Caraguatatuba/São Paulo, affected by the risks of the operation of a pressurized (100 kgf/cm^2) and large transmission pipeline (diameter of 34 in. and capacity of transportation of 15.000.000 Nm^3/day) that transfers natural gas from the Brazilian pre-salt field to an onshore processing plant. Despite the open area shown in the image on the left of Fig. 3 (from 2009), the pipeline route did bend towards the community. In 2011 the pipeline started up operation. From 2015, the image on the right side shows a new shopping mall developed near the ROW. Both the pipeline's proximity to the community (that could be prevented at the project's conceptualization) and the development of a new mall near of an existing ROW (that could be prevented by local land-use

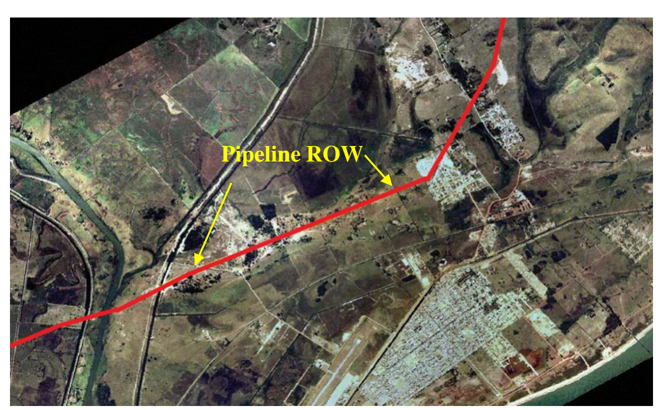

Fig. 1. City of Macaé, aerial photo taken in 2001 (scale 1:20,000). The red line is the pipeline right-of-way. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)
(Source: PETROBRAS/ENGENHARIA/IETEG/ETEG/EAMB - Engenharia de Avaliação Ambiental.)

[1] A regulatory framework refers to the coordinated regulation of diverse subjects, often correlated, by different institutions on a complementary basis.