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Perceived risks, emotions, and policy preferences: A longitudinal survey among the local population on gas quakes in the Netherlands



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ABSTRACT

Energy production can pose risks, such as nuclear accidents, oil spills, and earthquakes caused by gas production. Besides experts' evaluations of risks, appropriate risk assessment and management require knowledge about how people experience these risks and which mitigation measures they prefer. Media are often the sole source of information about public risk perceptions. Yet, media typically only report the most severe risks. By studying perceptions of different types of risks – among people with varying exposure to risks – we demonstrate how social science research can complement media reporting. We conducted a longitudinal questionnaire study into public risk perceptions of earthquakes caused by gas production in the province of Groningen, the Netherlands. While the media have reported multiple high risks and strong negative emotions, we found that people were mostly concerned about the risks for properties and for the image of the province of Groningen. Feeling powerless was the strongest negative emotion. People also evaluated mitigation measures as urgent but poorly implemented. Our results suggest that appropriate risk assessment and management need to follow a multi-method approach. This should incorporate multiple levels of analyses, including media reports, social science research on public risk perceptions, and experts' evaluations of risks.

1. Introduction

Energy production may pose serious risks. Examples include nuclear accidents, oil spills, water contamination and tremors from shale gas production, leakages from CO₂ capture and storage, and breaks of the dams of hydro-power plants. As such, energy production poses not only technical but also societal challenges [1–3]. Besides experts' evaluations of risks, adequate risk assessment and management require knowledge about how people perceive and experience these risks and which mitigation measures they prefer. Media reports are often the sole source of information about public risk perceptions. We argue that relying solely on media reports may provide a narrow understanding of public risk perceptions and preferences, and may therefore hinder adequate and responsible decision making. We aim to demonstrate in this paper that social science research has important added value as a source for appropriate risk assessment and management. Therefore, social science needs to be incorporated together with other types of analyses, such as media reports and experts' evaluations of risks.

1.1. Assessing perceived risks

Policy makers often (need to) rely on the media to assess public risk

perceptions associated with energy production. Yet, research suggests that people who perceive highest risks and who are most concerned about certain types of energy production are most likely to engage in actions such as protests and public meetings [4], making it more likely that their views are overrepresented in the media. Indeed, there is a trend in the media to engage the audience by reporting “scarce stories” and stressing high rather than low risks [5]. Such media analysis is informative because it signals whether there are societal concerns about energy production and it reveals which risks are most prominently discussed. At the same time, however, if policymakers rely *only* on the media, they may get a narrow understanding of public risk perceptions and preferences. For example, policymakers may overgeneralize the high risk perceptions reported in the media to the general population and think that everyone perceives the risks as equally high. This can be counterproductive. Policymakers may not further communicate the risks to people – and encourage them to take or accept actions to protect themselves against these risks – if they conclude from the media reports that people are already motivated to take these actions [6].

Social science research can complement media analysis by systematically studying the extent to which the risk perceptions presented in the media are shared by the population in general. Such research can reveal whether public risk perceptions in general align with or differ

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from media reports and/or experts' evaluations of risks, and why this could be the case. For example, studies have found that people who are exposed to high risks may downplay these risks for themselves – a result of the optimism-bias [6]. Students in California who lived in dormitories that were not earthquake-proof tended to evaluate the risks of earthquakes for themselves as lower than students living in earthquake-proof dormitories [7]. Optimism biases may have detrimental consequences if they reduce people's motivation to take action to protect themselves against risks (e.g., the risk of earthquakes [8,9], floods [10,11]; see also [6,12]). In case people do not face high risks themselves, they may hear about the high risks of energy production activities from the media and/or from other people. An interesting question here is how they integrate such information into their risk perceptions and whether they distinguish between the risks for themselves and the risk for others.

The media typically reports that people are concerned about many risks of energy production [13]. Yet, for effective risk assessment and management, it is important to understand how people perceive *different types* of risks and which risks they perceive as most likely and most severe. Such knowledge can complement the experts' evaluations of risks in setting priorities in risk mitigation policy. Furthermore, it is important to not only understand cognitions but also consider the emotions that people experience towards (the risks of) energy production, since such emotions may play an important role in people's willingness to take action and/or accept policy to protect themselves against risks [6]. Besides studying emotions that may motivate people to protect themselves against risks, such as anger, it is crucial to map out emotions that may inhibit people to take protective measures, such as feeling powerless [14].

Furthermore, in order to better understand the dynamics of risk perception, it is necessary to study how perceived risks, emotions, and preferences for mitigation measures develop over time. For example, three months after the California earthquake in 1989, Californian university students evaluated their own risk of being hurt in a natural disaster – such as earthquake – as lower than the same risk for an average student at their university and for an average person of their age living in their region, which suggests optimism biases [15]. Yet, optimism biases were not observed immediately after the earthquake [15]. Furthermore, research suggests that experience of an earthquake eliminated optimism biases five months after the earthquake [16]. Studies employing longitudinal research designs to study changes in risk perceptions are however rare [17]. Yet, perceived risks of energy production are likely to be continuously influenced by multiple factors, such as people's experience of risks, media attention to these risks, and mitigation measures that have been implemented. Monitoring risk perceptions over time in such complex contexts is crucial for appropriate risk assessment and management, and for evaluation of the effectiveness of mitigation policies.

Based on the above, we argue that appropriate assessment and mitigation of risks posed by energy production should follow a multi-method approach. This should incorporate different levels of analyses, including social science research on public risk perceptions, media analysis, and experts' evaluations of risks. In the present study, we demonstrate the added value of the first approach: social science research to better understand public risk perceptions, emotions, and preferences for mitigation measures. To illustrate, we studied risks associated with earthquakes caused by gas production in the province of Groningen, the Netherlands.

1.2. Earthquakes caused by gas production in the province of Groningen

Natural gas forms the largest share of the total energy mix in the Netherlands; the total share was 40% in 2014 [18]. Natural gas in the Netherlands is the primary energy source for households for heating houses and water and for cooking [19]. NAM (Nederlandse Aardolie Maatschappij) operates gas extraction; the company is owned by Shell

and ExxonMobil. Decisions about gas extraction are made by a partnership between NAM and EBN (Energie Beheer Nederland); the latter is a state-owned company. The Dutch government is financially involved in gas extraction via EBN [20]. The income from domestic use and export of gas to the national budget was 5.7 billion euros in 2016 [21]. A recent study revealed that a representative sample of the Dutch population evaluated gas positively in terms of consequences for the Dutch economy, people's daily comfort, and meeting energy needs in the Netherlands [22]. Gas was evaluated neither negatively nor positively with regard to consequences for the environment and people's health and safety, and rather negatively on the financial costs for people [22].

Recently gas production in the Netherlands has been much debated because of earthquakes induced by gas production. The earthquakes have taken place in the province of Groningen in the north of the country, where most of the gas is produced. Multiple earthquakes in the region have been observed, with a maximum strength of 3.6 on the Richter scale (the Huizinge earthquake in August 2012). The intensity and frequency of earthquakes varies across regions in the province of Groningen. In January 2013, the State Supervision of Mines (SoDM) published a report stating that stronger earthquakes can be expected if gas production continues at the same level [23]. This demands legitimate policy and effective risk mitigation measures in order to protect local communities and safeguard their quality of life. So far, the media have been a dominating source of information about public responses to earthquakes caused by gas production. Below, we summarise a published analysis of media coverage on this topic [13].¹ Next, we describe the mitigation measures that have been implemented so far. Following this, we introduce the key research questions and the related findings of the current longitudinal survey.

1.2.1. Risk perceptions in the media

Since the strongest earthquake in August 2012 there has been increased attention to the risks of earthquakes in the media and in public and policy debate. A qualitative analysis of the media coverage on earthquakes suggests that this corresponded with increasing concern about earthquakes among local communities [13]. According to the media analysis, public concern was amplified by the SoDM report [23], which stated that even stronger earthquakes may happen in the future: "People in Groningen had known about the earthquakes for years and had lived with them without much concern, but the SoDM report with its prognosis of increasing severity of earthquakes and increased impacts led many people to reconsider their opinions, leading to considerable consternation at the local level" ([13], p. 1). The media analysis further suggests that people became increasingly concerned about many risks of earthquakes, such as damage to houses and drop in house values, as well as risks for physical and mental health. Furthermore, strong emotions, such as anxiety, fear, insecurity, and anger, have been depicted in the media [13].

1.2.2. Mitigation measures

In January 2014, nine municipalities in the earthquake region, the national government, and the province of Groningen agreed upon a package of mitigation measures [24]. Some of these measures are focused on preventing and/or reducing the risks and damage caused by earthquakes. For example, in March 2014, the minister of economic affairs decided to reduce gas production in and around the municipality of Loppersum, which has been most affected by the earthquakes [25]. Other examples are reinforcing houses and compensating people for damage to their houses and the drop in house values. The other measures are aimed at safeguarding or improving quality of life in the region and do not specifically target the risks of earthquakes. Examples are providing facilities such as fast internet and sports

¹ The media analysis was conducted mostly in 2013 [13].

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