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The concept of ignorance in a risk assessment and risk management context

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ABSTRACT

There are many definitions of ignorance in the context of risk assessment and risk management. Most refer to situations in which there are lack of knowledge, poor basis for probability assignments and possible outcomes not (fully) known. The purpose of this paper is to discuss the ignorance concept in this setting. Based on a set of risk and uncertainty features, we establish conceptual structures characterising the level of ignorance. These features include the definition of chances (relative frequency-interpreted probabilities) and the existence of scientific uncertainties. Based on these structures, we suggest a definition of ignorance linked to scientific uncertainties, i.e. the lack of understanding of how consequences of the activity are influenced by the underlying factors. In this way, ignorance can be viewed as a condition for applying the precautionary principle. The discussion is also linked to the use and boundaries of risk assessments in the case of large uncertainties, and the methods for classifying risk and uncertainty problems.

1. Introduction

In this paper we study the ignorance concept in a risk assessment and risk management context. Many definitions and perspectives exist explaining what ignorance means. We have identified three main lines of definitions (refer to the review and discussion in the next section):

(i) ignorance expressing the same as uncertainty, i.e. lack of knowledge,
(ii) ignorance expressing a situation where a poor basis exists for the assignment/estimation of probabilities, and
(iii) ignorance expressing a situation where the definition of a complete set of outcomes is problematic.

In addition, there are combinations of these basic definitions. In this paper we discuss the relationship between ignorance as defined in (i)–(iii) and the concepts of risk and uncertainty. There is obviously a connection, but an analysis is required to obtain more formal structures. The aim of the paper is to provide such structures. The work is motivated by the need to strengthen the scientific platform of the risk discipline by providing new insights into the relationship between ignorance, uncertainty and risk. For this discipline, as for all other scientific disciplines, it is essential that the conceptual basis is solid. However, the present work is not only of theoretical and foundational interest. The main contribution of the paper is not the definition of ignorance as such, but the structure developed to understand and analyse the related features of risk and uncertainties in a risk assessment and risk management context. The analysis of the paper is closely linked to the discussion on the role of risk assessment in the case of large uncertainties and ignorance—to what extent should risk assessment be used and what are the boundaries of risk assessment in such situations? The work also relates to the definition of the precautionary principle, and it provides structures for classifying risk–uncertainty–ignorance problems. Such classifications are useful for defining appropriate management policies and strategies [1].

The analysis is based on a broad perspective on risk, as defined by Aven and Renn [2]. According to this perspective, risk equals uncertainty about and severity of consequences of an activity with respect to something that humans value. In line with this risk perspective, risk can be formalised as (C,U), where C represents the consequences (or the severity of the consequences) and U represents the uncertainty about what value C will take. Often (initiating) events A (for example a leakage, a fire, an attack) are added so that risk equals (A,C,U). Events A may occur, leading to consequences C. There are uncertainties about A (will the events occur or not) and what the consequences C will be. To describe/quantify the uncertainties, probabilities P are used and this leads to a risk description (A,C,U,P,K), where K is the background knowledge that the assignments of P and U are based on [38].

This perspective is general and many other risk perspectives can be viewed as special cases of this perspective or they can be considered to provide risk indices reflecting aspects of the risk [2]. The relationship between risk, uncertainty and ignorance depends

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on the risk perspective, but as will be clear from the coming sections the main findings and conclusions of this paper are also applicable to other risk perspectives, with some adjustments.

The remainder of the paper is organized as follows. In Section 2 we give a brief review of common perspectives and frameworks for understanding the concept of ignorance, as a basis for the analysis in Section 3. The aim of Section 3 is to present a conceptual framework for characterising ignorance and linking ignorance, risk and uncertainty. In Section 4 we discuss the framework and link it to the applications mentioned above: the definition of the precautionary principle, the use of risk assessment and the classification of risk–uncertainty–ignorance problems. Section 5 provides some conclusions and final remarks.

2. Review of common perspectives on ignorance

According to Pezzulo et al. [3], ignorance is a subjective evaluation of actual lack of information on the basis of cognitive evidential models. Ferson and Ginzburg [4] refer to epistemic uncertainty as (partial) ignorance. Stirling [5] refers to ignorance in circumstances where there not only exists no basis for the assigning of probabilities, but where the definition of a complete set of outcomes is problematic. Recognition of the condition of ignorance is an acknowledgement of the possibility of surprise, according to Stirling [5]. Also, other researchers and analysts refer to ignorance as situations where the possible outcomes are not (fully) known; see Klauer and Brown [6]. A frequently used framework for the studies on this issue is the distinction between risk, uncertainty and ignorance, in line with the Knightian classification scheme [6].

Risk: possible outcomes (sample space) known. Probabilities known.
Uncertainty: possible outcomes known. Probabilities unknown.
Ignorance: possible outcomes not (fully) known.

Following Knight [7], a distinction is made between risk and uncertainty, based on the availability of information. Under risk, the probability distribution of performance measures can be assigned objectively, whereas under uncertainty these probabilities must be assigned or estimated on a subjective basis.

However, this distinction between risk and uncertainty is not considered meaningful. It is in conflict with the common interpretation of risk [8,9] and will not be referred to later in this paper. Adopting this terminology, we cannot speak about risk in most practical applications as objective probability distributions cannot be determined. For example, *terrorism risk* as a term would make no sense in this conceptual framework. And the precautionary principle would not be a part of risk management as this principle extends far beyond the narrow term *risk* used in this classification.

Collingridge [10] states that under the condition of ignorance neither probabilities nor outcomes can be fully characterised. The same type of interpretation is adopted by The Health and Safety Executive (HSE) [11,12] in the UK, which describes ignorance as a situation with a high level of uncertainty in both probability and consequences, see Fig. 1. The vertical axis represents increasing uncertainty in the likelihood that harmful consequences of a particular event will be realised, while the horizontal axis represents increasing uncertainty about the consequences attached to the particular event. Uncertainty here refers to a state of knowledge in which influencing factors are known, but the likelihood of consequences (effects) or the consequences themselves cannot be precisely described. Ignorance, on the other hand, refers to lack of knowledge of factors influencing an issue, e.g. incomplete identification of hazards in a risk assessment.

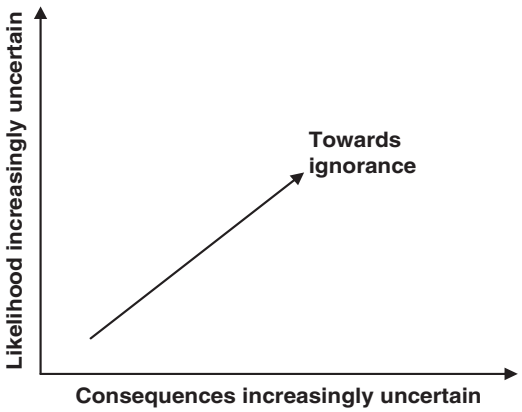

Fig. 1. Structure for characterising ignorance through increasing levels of uncertain likelihood and consequences (based on HSE (2001)).

This definition of ignorance resembles ignorance being understood as "unknown uncertainties" [13], i.e. cases where we do not know what we do not know, for example that a new terrorist group has been formed that attacks only special targets that were normally perceived as less attractive for the known terrorist groups. Faber et al. [14] talk about "closed ignorance"—we are not aware of our ignorance and feel no need for learning or research. If one become aware of one's closed ignorance, a state of open ignorance is reached. In this state one will try to understand surprising events by learning and research. If the ignorance is open it is distinguished between reducible and irreducible ignorances. If we cannot classify the ignorance according to these categories, the situation is referred to as "uncertain ignorance". Tannert et al. [15] present a similar uncertainty–ignorance structure inspired by the classification of Faber et al. [14].

Various definitions of ignorance link this concept to uncertainty and knowledge as demonstrated by the above examples. As an additional example we mention the use of ignorance in Bayesian statistics. Here the term is being used when specifying the prior probability distribution in the case of "complete lack of knowledge". In such cases, non-informative priors [16,17], ignorance priors [18] and reference priors are used. However, the issue of complete ignorance using such distributions is strongly debated in the literature, e.g. Barlow [19] and Jaynes [18]. According to Barlow [19], there is no logically valid way to express complete ignorance, and doing so is not desirable.

From this review we have identified three main lines of definitions as mentioned in Section 1: (i) lack of knowledge, (ii) poor basis for the probability assignments and (iii) possible outcomes not (fully) known. In a risk assessment and risk management context, these definitions represent the most common perspectives, but many others exist. To illustrate the variety of other definitions of the term "ignorance" we would like to draw attention to

- Smithron [20] and Thompson [21], who refer to the following different forms of ignorance:
  - all the things, which people are aware they do not know.
  - all the things people think they know but do not (error).
  - all the things which people are not aware that, in fact, they do know (intuition).
  - all the things people are not supposed to know, but could find helpful (taboo).
  - all the things too painful to know (psychological suppression of memory) and