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Implications of black swans to the foundations and practice of risk assessment and management

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ABSTRACT

In this article, we discuss how to deal with black swans in a risk context. A black swan is here understood as a surprising extreme event relative to one's knowledge/beliefs, and can be of different types: a) unknown unknowns, b) unknown knowns (we do not have the knowledge but others do) and c) events that are judged to have a negligible probability of occurrence and thus are not believed to occur. In the article, we review the current approaches for confronting black swans, the aim being to gain new insights by addressing the three types of black swans separately, motivated by the fact that they require different types of measures. The main conclusions of the article are that there is a need to i) extend the current risk conceptualisation and treatment frameworks to include the black swan risk, ii) develop a new generation of risk assessment and decision support methods that place more emphasis on the black swan risk and iii) better understand what analysis captures and what lies within the management domain.

1. Introduction

Three major strategies are commonly used to manage risk: risk-informed, cautionary/precautionary, and discursive [33]. In most cases the appropriate strategy would be a mixture of these three. The risk-informed strategy involves the treatment of risk – avoidance, reduction, transfer and retention – by the use of risk assessments. The cautionary/precautionary strategy is also referred to as a strategy of robustness and resilience, and highlights features such as containment, constant monitoring, research to increase knowledge and development of substitutes. In the discursive strategy, measures are employed to build confidence and trustworthiness, through the reduction of uncertainties, clarification of facts, involvement of affected people, deliberation and accountability.

In this article, we focus on risk related to black swan type of events, here understood as surprising extreme events relative to one's knowledge/beliefs [5]. How should we confront this risk?

Taleb proposes "to stand our current approaches to prediction, prognostication, and risk management on their heads" ([41], p. 4, 5). When looking at much of the current thinking about risk assessment and management, with its focus on probability modelling and estimations, Taleb's view is understandable. However, risk management is required in order to find the proper measures to confront the occurrence of potential events. There are always limited resources available for this purpose, and the risk assessment provides decision support. The decision makers need to be informed about issues related to important precursors, the uncertainties, the knowledge available and so on. In a particular case, a decision maker may need to choose between investments in some measures that are effective in the case of some events but not in others, and investments in other measures with the reverse effect. Accurate predictions and estimates cannot be provided but, in most cases, informative risk descriptions can. This perspective seems to be the one adopted by Paté-Cornell [31] in her thought provoking analysis of how to confront the black swan risks. She takes an engineering risk analysis perspective, which highlights information gathering and analysis in support of proactive risk management decisions; due weight is given to the reinforcement of relevant systems, and thoughtful response strategies are developed.

In this article, we review current approaches to confronting black swans, having a special focus on the risk analysis approach and robust/resilient thinking. By distinguishing between different types of black swans, the article seeks to gain new insights on how to best deal with black swans. A specific issue raised is the use of risk assessments in such settings. What form and role can and should they take to provide useful decision support?

The article is organised as follows: First, in Section 2, we provide a detailed analysis of the concept of black swans. To provide a meaningful study on how to confront black swans, it is essential to have a clear understanding of this concept and the different types of black swans. Then, in Section 3, we perform the aforementioned review and discussion of some current approaches to confronting these

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events. This review is followed up in Section 4 with a discussion of how to meet the different types of black swans. Finally, Section 5 provides some conclusions.

The most novel part of the article is Section 4, where the analysis relates to a recent categorisation of black swans. However, also the other sections present to a large extent new and original material, by integrating and reflecting upon existing work, providing conceptual clarifications (as in Section 2), as well as providing guidance on how to best confront the black swans.

2. What is a black swan?

The metaphor and concept of the black swan has gained a lot of attention recently and is a hot topic in many forums that discuss safety and risk. In the scientific community it has also been a focus in the aftermath of Nassib Taleb's *The Black Swan* [40]. Taleb refers to a black swan as an event with the following three attributes. Firstly, it is an outlier, as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. Secondly, it carries an extreme impact. Thirdly, despite its outlier status, human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable. Other definitions of black swans have also been suggested. Aven [5] refers to a black swan as a surprisingly extreme event relative to one's belief/knowledge, and in Aven and Krohn [8] three main types of black swan events have been identified based on this definition:

a) Events that were completely unknown to the scientific environment (unknown unknowns)
b) Events not on the list of known events from the perspective of those who carried out a risk analysis (or another stakeholder), but known to others (unknown knowns – unknown events to some, known to others)
c) Events on the list of known events in the risk analysis but judged to have negligible probability of occurrence, and thus not believed to occur.

The term "black swan" is used to express any of these types of events, tacitly assuming that it carries an extreme impact.

The first category of black swan type of events (a) is the extreme – the type of event is unknown to the scientific community. A good example is the effects of the thalidomide drug [38]. The drug was introduced in 1957 and not long after children were observed with gross limb malformations of an unusual form. In activities about which there is considerable knowledge, such unknown unknowns are likely to be rarer than in cases of severe or deep uncertainties.

The second type of black swans (b) is events that are not captured by the relevant risk assessments, either because we do not know them or we have not made a sufficiently thorough consideration. If the event then occurs, it was not foreseen. If a more thorough risk analysis had been conducted, the event could have been identified. The September 11 attack is a good example of this type of black swans.

The third category of black swans comprises events that occur despite the fact that the probability of occurrence is judged to be negligible. The events are known, but considered so unlikely that they are ignored – they are not believed to occur and cautionary measures are not implemented. An example is the event that an underwater volcano eruption occurs in the Atlantic Sea leading to a tsunami affecting, for example, Norway. The events are on the list of hazards and risk sources but then removed as their probability is judged as negligible. Their occurrence will come as a surprise. The tsunami that destroyed the Fukushima Daiichi nuclear plant was similarly removed from the lists due to the judgement of negligible probability.

The black swans' "surprising" aspect must always be understood in relation to by whom and when. Figs. 1–4 illustrate this. We consider an activity, for instance, the operation of an offshore installation, at a given future time period, for example, next year. We let C denote the consequences of the activity in relation to the values we are concerned about (life, health, environmental, assets). What C will be is unknown to us at time s; there are risks

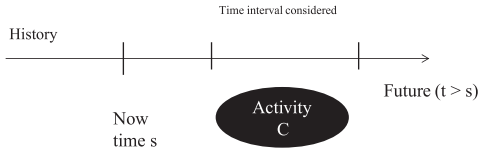

Fig. 1. Illustration of risk in relation to the time dimension. C: consequence of activity.

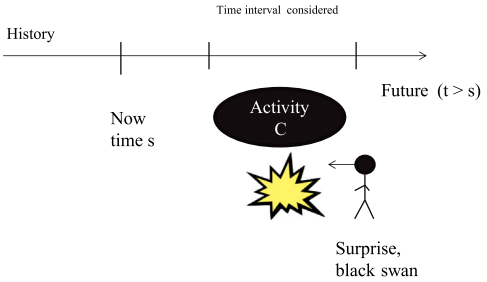

Fig. 2. Illustration of relationship between risk, black swan and the time dimension.

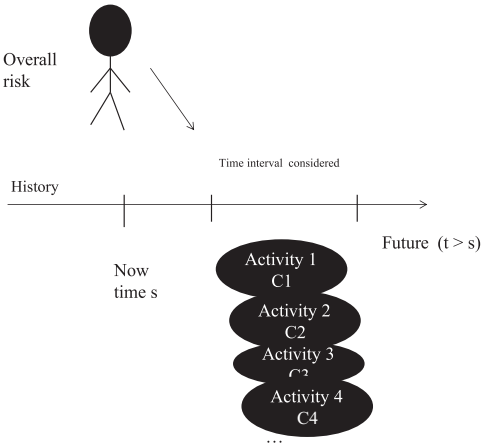

Fig. 3. Illustration of risk in relation to the time dimension when the perspective is macro, for example the whole oil and gas industry.

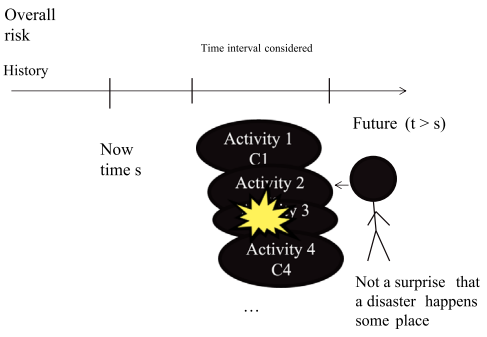

Fig. 4. Illustration of relationship between risk, black swan and the time dimension when the perspective is macro, for example the whole oil and gas industry.