Chapter 2

Understanding disaster risk: risk assessment methodologies and examples

David C. Simmons
Coordinating lead author

David C. Simmons
Lead author 2.1

Rudi Dauwe
Richard Gowland
Zsuzsanna Gyenes
Alan G. King
Durk Riedstra
Stefan Schneiderbauer

Christina Corbane
Lead author 2.2

Paolo Gamba
Martino Pesaresi
Massimiliano Pittore
Marc Wieland

Stefan Schneiderbauer
Lead author 2.3

Elisa Calliari
Unni Eidsvig
Michael Hagenlocher

Scira Menoni
Lead author 2.4

Costanza Bonadonna
Mariano García-Fernández
Reimund Schwarze

Jochen Zschau
Lead author 2.5

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Introduction

Definition of risk

There is no commonly accepted definition of risk. According to the United Kingdom's Royal Society (1992), risk is 'the probability that a particular adverse event occurs during a stated period of time, or results from a particular challenge'. By contrast, the latest UNISDR's definition (2017) of disaster risk is 'the potential loss of life, injury, destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity'.

Disaster risk is not just about the likelihood and severity of the hazard event but also about what is exposed to that hazard and how vulnerable that exposure is. A severe earthquake in a relatively uninhabited region can be of far less consequence than a relatively minor one near a large conurbation. Similarly, a severe earthquake in an area known to be prone to earthquakes and so with strict design and construction standards can cause fewer fatalities and less damage than an unexpected, much smaller one in an unprepared area with poor building standards.

Following the Sendai disaster risk definition, we may consider risk to comprise of three elements.

1. Hazard: the adverse event causing the loss.
2. Exposure: the property, people, plant or environment that are threatened by the event.
3. Vulnerability: how the exposure at risk is vulnerable to an adverse event of that kind.

Note that the forth Sendai element; capacity, the ability of the system to respond after the event to mitigate the loss, is generally considered to be a component of vulnerability. Loss suffered, that is the damage caused to the exposure at risk to a defined hazardous event, will depend upon these elements.

Risk complexity and dependency

Single events may have no one single cause. For example a major flood could be caused by a combination of one or more of heavy rain, unseasonably high temperatures causing snow to melt fast, baked land from a prior dry spell or conversely saturated soil from earlier continuous rains, which both increase run-off, high tides and storm surge.

Whilst it is sometimes difficult to consider risks from a single hazard, what of their combinations? The major cause of death and damage following the Great Kantō earthquake affecting Tokyo in 1923, an event that left more than

140 000 people dead or missing, was not from building collapse due to ground shaking but from fire storms provoked by cooking equipment knocked over in the event. Similarly, earthquakes may cause tsunamis, landslides, dam failures or avalanches and windstorms may cause landslides, storm surge, floods or flash floods. Vetere Arellano et al. (2004) includes a fascinating example of cascading risk following an earthquake in Turkey in 1999.

Human action can also affect the loss. For example, canalising rivers or building on historical floodplains can give excess flood water nowhere to go; wide-scale concreting over gardens to provide hard standing for motor cars prevents water absorption, perhaps exacerbated by inadequate or poorly maintained drains. What historically would have been a benign event can now become a calamitous one.

Uncertainty and subjectivity

Risk includes elements of the scientific and the subjective. In some hazards or sectors, risk can be clearly defined. For example in the insurance industry, the 'risk business' defines property or people who are normally insured against defined hazards with payment made upon financial loss suffered. As we will discuss later, this has led to an explosion in risk analytics over the last 30 years, leading to a far more technically sophisticated but also financially secure insurance industry.

However, even here there are limits in what we know. We may feel we know how well a particular building will react to an earthquake of a certain intensity, but do we know it was built to the right standard or correctly maintained? We may feel we can reasonably estimate the damage that a flood with a depth of 1 metre can do to an industrial plant, but how well can we estimate the firm's economic loss related to this damage, which will depend on how quickly the plant may be repaired or replaced, on whether it has any other factories available to take some of the strain and on whether business temporarily lost can ever be fully regained.

There is an inherent uncertainty, as by definition catastrophes are rare events; data to describe their effects may be partial, at best. However, as we will discuss later on, the process to understand and model risk sheds light on areas where data are lacking and therefore where additional focus is required. Subjective assumptions, perhaps currently unstated, must be made explicit and so held up for discussion.

Risk is not static but rather dynamic and dependent upon changes to hazard, exposure and vulnerability. Anthropogenic climate change is accepted as scientific fact, but its consequences on a local level and for a particular hazard may not be clear. Historical observations are often limited, partial and contaminated with natural variation and underlying factors that may not be fully understood. But clearly there is a public and therefore political pressure for governments to protect their populations against the impacts of climate change. In practice, though, the risk as it is now is very often not properly understood, and still less how it may worsen (or conversely improve) under different climate change assumptions in 30 years' time; understanding current risk is fundamental to understanding how that risk may change in the future.

Risk perception

When we begin to move into exposure, such as the preservation of habitat and/or animal population, it may be harder to place an agreed value on preservation or qualification of damage if either is impaired, even where there is common acceptance of the importance of the risk to society. A common risk metric must be agreed in order to allow, for example, the relative social and environmental cost of sacrificing an important ecological habitat to protect the human population of a city.

Humans have short memories; current risk concerns may be driven by recent experience rather than underlying loss potential. Few were concerned with tsunami risk until the tragic events of 2004 and 2011 — the risks were theoretically known but were rare, and crucially as no significant tsunami had been filmed until 2004, the risk was difficult to relate to and was often overlooked.

Indeed, perception of risk drives policy (Klinke and Renn 2002). For example, many more die on the road than in train crashes, but these deaths tend to come in ones and twos at any time, rather than several casualties, as in rail crashes. Post-loss this may lead to calls to improve the already relatively safe rail system when a similar amount spent on the road network may save more lives.

The public purse is not unlimited. Should the politician react to the public perception of risk by spending on risk prevention in areas of known public concern or try to assess the range of risks the population face and prioritise spending on a more rational cost/benefit approach? In the short term, pre-event, the former will be more electorally advantageous but the post-event failure to react to an unrecognised hazardous eventcould have enormous political as well as human consequences. It is vital to consider not just what has happened but what could happen; taking action to minimise loss in advance and not just reacting to events as they occur.

Recognising risk may also have its consequences. Many societies have a pressure on housing. Flood plains offer an easy solution, the land drained, defences constructed and houses built, which is popular as people like living near water. But how robust are the new properties in a changing climate? Can risk be overlooked if there is a social need? Certainly before the event, but what about after? What if the properties become uninsurable and so unsaleable?

The importance of understanding disaster risk

Risk is complicated, but understanding risk is vital to the proper protection of society and the environment. Without proper risk analysis, can appropriate policy decisions be made?

In an increasingly litigious society, could governments and officials not have a proper risk assessment methodology? It is vital to understand and use the best science, but ultimately policymakers will also necessarily react to stakeholder perception. It is hoped that scientific fact, properly presented, will drive perception, but ultimately risk management decisions are necessarily political.

Those decisions need to be made in a transparent manner; open to scrutiny, challenge and debate. It is impossible to completely eliminate risk, even with an unlimited public purse. In reality, budgets are under pressure, with many calls upon limited funds: spending money on preparing for an event that will probably not even occur within a politician's period of office may not be as high a priority as trying to address an immediate social need.

However, there is a duty of care to protect the citizens and the natural environment of Europe. Modern risk assessment, coupled with risk and financial modelling, provides the framework to make the right decisions for both now and the future.