STUDIE

Mapping of Risk Perception and Assessment -

Inspiring Methods for National Level Risk Mapping in Sweden

Faktaruta

Förstudie kompletterande perspektiv för att beskriva och presentera risker

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Förstudien tar fram ett underlag som dels kan ligga till grund för framtida kompletterande sätt att beskriva olyckor och kriser, dels kunna ligga till grund för framtida behov av och strategier för datainsamling. Rapporten analyserar 11 existerande rapporter internationellt och föreslår rekommendationer för en nationell svensk riskkartläggning som avslutas med ett empiriskt exempel.

Innehållsförteckning

Summary

Our modern society is exposed to multiple hazards and risks. To manage these successfully, it is important to have a good overview of the risks that potentially affect our society and how they are perceived and valued. This pilot study investigated possible ways of mapping and analysing risks that Swedish society and its inhabitants are exposed to and aware of. The aim was to capture complementary perspectives on accidents and crises, and to provide a point of departure for future planning and data collection strategies. To achieve this, previous studies are mapped and critically assessed and an example of a method of analysis is presented. The following questions have guided the work: 1) What methods are currently available to describe risks at a broader societal level? 2) What are the limitations, advantages and disadvantages of these existing methods? 3) Which of these methods are of relevance to Sweden? Summarizing previous studies, the report includes examples of methods, structures and data visualizations for mapping risks nationally or in larger regions. The report analyses 11 types of existing study or report as a source of inspiration and to scope existing gaps for potential improvement. The report makes recommendations for national level risk mapping in a Swedish context, supported by an empirical example.

1. Background

MSB collects data from multiple data sources for overall assessment of accident trends and associated risk management work. Its national collection is the largest single source of data on municipal civil protection efforts. Registry data are complemented by periodic questionnaires completed by members of the public to assess the nature and extent of unreported accidents and to capture people's attitudes and perceptions.

However, there are a number of knowledge gaps and areas where information is missing in whole or in part, which are of interest and would be useful for overall assessment. Relevant concerns in this regard include whether MSB's current data and methods of data collection offer any consistent means of describing the risk of rare events. Descriptions of perceived risk linked to such events are also lacking, and to capture the holistic distribution and perception of risks on a broader societal level, it is important to describe differences in risk perception based on variables such as socio-demographics. At present, risk description in MSB data is typically confined to a small geographical area, with no national level assessment. Existing assessments are mostly one-dimensional or capture a particular subgroup within a community, with limited potential for any holistic description of risk. There is, then, a need to identify methods and types of data that can capture holistic risk profile, perception and description at a national level in.

This report details a preliminary study exploring the possibility of a multivariate approach to data collection and visualization that can support the holistic description of risk at a broader societal level. Some existing precedents include the Global Risk Report, the Asia Risk Report and the National Risk Regimes Report prepared by the DSB, the Directorate of Civil Protection in Norway. These reports are of particular relevance because they describe risk at a broader societal level, offering a national overview of risk and descriptions of risk. In the current report, we revisit these examples in detail and examine their pros and cons. In conclusion, the discussion section considers how MSB might adopt a similar approach in Sweden.

1.1 Aim and purpose

The aim of this report is to provide an overview of how accidents and crises can be comprehensively described. The ultimate purpose is to raise risk awareness and to enhance understanding of different types of risk, including linkages, causal factors, possible impacts and probabilities, by assessing and mapping risk and risk perception at a broader level. To this end, the report gathers examples and precedents from various sources, both domestic and international, as a possible basis for future data collection to map risks in Swedish society. More precisely, the report aims to provide complementary perspectives on accidents and crises, and to serve as a point of departure for

future planning and data collection strategies. The report addresses three primary questions.

- What methods are currently available to describe risks at a broader societal level?

- What are the limitations, advantages and disadvantages of these existing methods?

- Which of these methods are of relevance to Sweden?

1.2 Previous research on spatial dimensions and inequalities: cartographic approaches to risk and resilience

In recent years, a number of studies within the field of geography have attempted a more holistic approach to mapping various environmental risks (e.g. Malczewski 2006) and health risks (e.g. Bell et al. 2007) at different locations, often by combining GIS and Multiple Correspondence Analysis. These studies may offer important insights for national risk mapping in Sweden, especially when taking account of spatial dimensions and social inequalities. Meyer, Scheuer and Haase (2009) proposed an approach that integrates assessment and mapping of economic, environmental and social flood risks, based on a three-step method. First, choose evaluation criteria for the different dimensions of risk; second, identify methods of assessing these risk criteria in a spatially differentiated way by creating risk maps for each criterion; and third, aggregate these different risk maps, using appropriate multi-criteria decision rules to arrive at an overall risk assessment and mapping.

Their work confirms that results will depend on the weights assigned to different criteria. For example, urban areas attract high-risk values if higher weight is assigned to social and economic criteria; in contrast, a higher weight on environmental criteria increases risk values in more rural areas. This emphasises the crucial role of weight determination in a multicriteria approach, along with the issue of who is authorised to participate in the decision-making process. The main significance of these examples is to highlight the importance of context and inequalities and how these shape the perception and implications of different risks. To take account of these factors, one possible method is 'participatory risk mapping' (McCall 2008), where local spatial knowledge (both community and individual), as well as being supplementary and cross-validating, is seen to add value in understanding risk situations and designing community-based amelioration. In mapping local knowledge—of hazard status, priorities, vulnerability, capacity, adaptation, coping mechanisms, overall risk, and so on—an initial step is to identify indicators that are locally acceptable and credible (Bankoff et al. 2004).

2. Research material

The present report is descriptive and draws on two kinds of material: previous reports on risk mapping and an explorative statistical analysis that might be applied to risk mapping. In this section, 11 international reports are reviewed in respect of their potential relevance, with critical summaries of the strengths and weaknesses of the methods employed. More detailed investigation of existing data and methods is beyond the scope of this report; instead, the focus is on how these existing methods can be adopted or adapted to inform national-level description or mapping of risks in Swedish society. Additionally, the report seeks to identify trends in other Nordic countries (e.g. Denmark and Norway) in mapping risks at both national and global level (as in the World Economic Forum's *Global Risk Report* and the *Asia Risk Report*). Table 1 below lists the studies referred to here for example, inspiration and possible action.

Table 1: Existing studies offering holistic descriptions of societal-level risk

Title	Country	Level of study/ analysis	Method overview
Global Risk Report	Not applicable	Global	Quantitative: MCA, Survey, Expert questionnaire, Network analysis
Asia Risk Report	Not applicable	Asia	Quantitative: MCA, Survey, Network analysis, Expert questionnaire
DEMA: Danish Emergency Management Agency	Denmark	National	Final report based on qualitative description
DSB: National Risk Regimes	Norway	National	Qualitative
National Hyogo Framework for Action Progress	Norway	National	
Public Stakeholder Consultation: H 2020	European Union	European Union	Survey design
Risk Assessment for Iceland: Global, societal and military factors	Iceland, Ministry of Foreign Affairs	National	Qualitative and Quantitative; involving a panel of interdisciplinary experts from academia and business, along with other practitioners
National Risk Assessment of Iceland	National Commissioner of Icelandic Police, Department of Civil Protection & Emergency Management	National	Qualitative. Based on expert assessments, risk matrix, RVA and risk matrix; to be used for scenario building in emergency planning; similar approach at local and national levels, with Civil Protection Districts using their own historical data for the NRA
National Risk Assessment: Ireland		National	Use of conventional RVA method and risk matrices to arrive at conclusions; expert discussions used to describe, define and agree acceptable limits for each risk and for risk identification
National Risk assessment: UK		National	Use of conventional RVA method and risk matrices to arrive at conclusions; expert discussions used to describe, define and agree acceptable limits for each risk and for risk identification
National Risk Assessment: Finland		National	Use of RVA and risk matrices to arrive at detailed risk scenarios as the basis for NRA

3. Summary of existing studies

This section presents an overview of existing studies and data in which risk and its distribution is holistically captured and mapped at societal level. Eleven studies or reports are analysed to identify the methods used, the types of data collected and the studies' overall scope. Each of the selected studies is summarised and revisited in detail.

3.1 Global risk report

This report is prepared each year by the World Economic Forum; the example used here is from the 11th edition, published in 2016. The aim of the report is both to raise risk awareness and to elaborate on current trends in relation to risks, their impacts and their interconnections. The *Global Risk Report* is among those that take account of worldwide data on risks, historical trends and impacts. The World Economic Forum bases this report on multi-stakeholder risk perception across the global community, conducting surveys across all sectors. The analysis and preparation of the report also involves collaboration across multiple sectors worldwide. The 750 respondents include business leaders, experts and academics. The report is divided into three parts; the first focuses on risk perception, identification and their interconnections; the second part discusses the implications; and the third part is based on a meta-analysis highlighting risk clusters and possible implications for social stability and security.

3.1.1 Data

The report draws on data from the Global Risk Perception Survey (GRPS), applying analytical tools such as Multiple Correspondence Analysis (MCA) and Principal Component Analysis (PCA). Expert consultations in the form of workshops, seminars, focus groups and panel discussions are conducted before and after the GRPS to formulate risk clusters. Meta-analysis of the survey data identifies interconnections between risk clusters before projecting the impact and likelihood of these risk clusters into two major categories. The first of these relates to impact and projected change in business trends and economic decisions, and the second relates to changes in social stability, with reference to national and international security issues and threats arising from these changes.

It should be noted that, unlike other national or international reports, the *Global Risk Report* is not utilized for emergency preparedness and planning or training. Instead, it serves the broader purpose of capturing risk perceptions and identifying essential interconnections between risk clusters in order to understand the vulnerabilities and challenges associated with current trends. The report's conclusions assist decision makers and business leaders in various sectors to identify challenges and mitigating actions by understanding risk trends and impacts on the national and global economy.

The report also provides a breakdown of GRPS respondents according to their domain of expertise, sector (private, public, or academic) and skills, as well as gender and age distribution.

3.1.2 Method

3.1.2.1 Risk categories, risk clusters, interconnections, impacts and probabilities
The report uses the GRPS data to generate risk categories, clusters and their probability and impact. The risk categories are as follows:

- Economic

- Environmental

- Geopolitical

- Societal

- Technological

All risk categories are colour coded for clearer representation of interconnections and their strength. The report draws on the GRPS, where respondents are asked to identify the risks, to group these into five categories and finally, to cluster the risks in pairs, based on perceived interconnections. The report represents the interconnections in graphic form to highlight risk clusters and the strength of interconnections, linking these risks to underlying systems that might potentially compound the impact of these risk clusters. These holistic connections are extremely helpful for informed decision making and mitigating measures that address entire risk clusters rather than single risks. The GRPS data on interconnections are analysed using MCA and PCA to determine the strength of connections and any positive or negative correlations.

Respondents indicate the likelihood of each risk on a scale from 1 to 7, where 1 denotes 'very unlikely' and 7 denotes 'very likely'. Similarly, in relation to impact, 1 denotes 'low impact' and 7 denotes 'high impact'. The report also presents the distribution of these risks in graphical form, based on changing trends (in likelihood and impact indicators) from the previous two years. Likelihood is further classified into two categories, referring to the most likely risks in the next 18 months and in the next 10 years.

3.1.2.2 Risk descriptions, categories and definitions
Risk descriptions and definitions are specified for each risk category in the GRPS. These definitions and descriptions are based on a separate survey and on several rounds of seminars, workshops, panels and focus groups involving experts and decision makers from various fields and countries. In the 11th edition of the *Global Risk Report*, published in 2016, 29 risks were identified, mapped and assessed.

3.1.2.3 Meta-analysis of global risk landscape
The report also presents a global risk landscape, based on a comparison of data from 2006 to 2016 and ranking the top risks in terms of likelihood and

impact. In addition, the report offers a geographical meta-analysis that discusses continent- or region-specific risk landscapes and trends. The report acknowledges that the risk landscape is not fully comparable over the 10-year period, as many of the risks have been re-categorized, some definitions have evolved and many new risks have emerged. In other words, the set of risk clusters and categories changes over the period 2006–2016. Nevertheless, this approach offers real insights and a global overview of how the perception, identification, impact and likelihood of risk changes over time, highlighting the need for changing strategies and better awareness to address such risks and mitigate them.

3.1.2.4 Scenario building and resilience strategies in robust decision making: The final part of the *Global Risk Report* includes scenario building and identification of strategies for robust decision making to address emerging trends. This is based on two data sources: the GRPS and the expert discussions referred to above. All scenarios are based on the implications and projected likelihoods of current risk trends. The report emphasises long-term impacts on business and the challenges of business continuity, taking account of current risk trends in all categories—societal, environmental, geopolitical, financial, natural and technological.

3.1.3   Limitations

The *Global Risk Report* provides a holistic overview of risks, their interconnections, geographical impacts and projected likelihood. While this approach may not be sufficient to construct training and preparedness plans at national or regional level, it highlights the value of national and international level risk overview for strategic decision making purposes. In combination with national and regional level data, as well as historical records emphasizing local trends, it seems a useful framework for a national risk assessment plan.

The report uses the powerful and holistic GRPS to address several aspects of risk and associated perception and awareness. However, the indicators of impact and likelihood as ranked by survey respondents are not covered in sufficient detail. Despite the graphical representation of financial losses incurred in various geographical regions (such as the United States) from the perspective of long-term impacts on business, the basis for assessing the impact on societal assets, aspects and other demographic considerations is not clarified in the current report but refers to previous editions.

3.2   Asian risk report

The *Asia Risk Report* was published in 2015 by *Strategic Risk* magazine as part of its pan-Asian research project. The report is based on large and comprehensive surveys of business leaders, insurance managers and consultants, with a mutual focus on business risks and mitigation strategies. The magazine explores national as well as pan-Asian trends with international partners from different Asian countries, including prominent business leaders and centres of excellence in business education and analytics. In addition to a comprehensive survey, Strategic Risk also engages its partners in several rounds of seminars and workshops. The report is divided into three main

sections. The first of these deals with risk categorization, definitions, description and connectivity. The second part focuses on some of the systemic failures and causal factors that compound these risks and require immediate attention. The third part of the report identifies the top risks in different countries across Asia.

3.2.1 Data

The data source was a comprehensive survey of 145 respondents from various industries across Asia. Although the respondents had disparate job titles and came from a range of age groups, all were dealing primarily with risk, business continuity and insurance. In addition to the survey, the *Asia Risk Report* also draws on data from expert discussions, which involved experts from centres of excellence in business education and planning, as well as industry decision makers.

3.2.2 Method

The overall methodology of the Asia Risk Report is similar to that employed in the 2016 edition of the *Global Risk Report*. Respondents were asked to rate 35 different risks on a scale of 1 to 5 for likelihood of occurrence in the next 12 months and estimated financial impact on their business. To identify the risks of highest concern (that is, most likely to occur with the highest financial impact), a combined average score was calculated for each risk, and risks were ranked accordingly.

The approach adopted to identify risk connections was similar to that in the *Global Risk Report* (see section 2.2.1). Respondents were asked to identify the risks most connected to their business, and to choose up to five pairs of risks that they believed were most connected from a list of 35. Strengths and directions of interconnection were analysed using MVA, PCA and correlations. Again as in the *Global Risk Report*, different risk categories were colour coded to clarify these interconnections. Based on responses to the impact, likelihoods and risk connection items, each of the top five identified risks were discussed in detail in relation to long-term implications for business and strategy. Causal factors were also investigated in greater depth.

The report also provides demographic and other details of the 145 experts, insurance managers and business leaders who participated in the study. These include distribution by country and company size, as well as industry type, job title, seniority and gender distribution.

The final part of the report details top risks by country, along with possible mitigation measures and business continuity plans. In formulating conclusions, this section also refers to case studies of prominent business houses and industries from each country, expert discussions and comprehensive survey data on risk perception.

3.2.3 Limitations

The *Asia Risk Report* provides comprehensive risk awareness and analysis from the perspective of business continuity, but there is no detailed analysis of impacts on society, environment or overall development. The number of

respondents is also quite low and does not include public sector decision makers in the survey or expert discussions. While the report addresses overall risk awareness in the business sector, and especially in the corporate sector dealing with insurance, it may be of limited operational value in terms of scenario design or planning for public sector decision makers and government departments.

Nevertheless, both the analysis and the comprehensive methodology and targeting offer a useful precedent for research in the public sector. Combining historical data with similar surveys and analysis, government departments and public sector enterprises can achieve a richer analysis and more holistic overview of risks at international, national and regional levels.

3.3 Public stakeholder consultation – interim evaluation of H 2020: European Union

The document referred to employs a survey design. It is included here as a useful international precedent for national level risk mapping by MSB in Sweden, primarily because of its method, which is discussed below.

3.3.1 Data

The data to be collected are qualitative. Additional qualitative text responses can also be shared, and strength of agreement, choice and motivation can also be provided in the form of qualitative text.

3.3.2 Method

The survey employs a qualitative approach to collect comprehensive information based on Likert scale choices and qualitative texts related to the motivation for those choices. This approach emphasises consultation and meaning and is designed to capture public stakeholders' opinions in a comprehensive manner. As H 2020 is a scientific innovation project to facilitate research, education and technological advances and knowledge generation in relation to economic and societal challenges in EU member states, the survey questions range from sector affiliation to opinion gathering.

The survey is divided into six sections. The first section begins with questions about organization affiliation and type (e.g. institute, university, government authority) and partnerships in applying for H 2020 grants. The second section captures public stakeholders opinions about whether and to what extent H 2020 research innovation has addressed scientific and societal challenges—for example, by generating jobs, addressing climate policy concerns, increasing EU capacities, creating markets, or achieving a more transparent industrial base. The third section of the survey captures opinions and insights related to the implementation and overall relevance of H 2020; respondents can add qualitative texts to highlight specific aspects that might be improved. The fourth section relates to efficiency and added value, capturing opinions and insights on joint training, cooperation and innovation for knowledge generation. This section also addresses the specific relevance of aspects of H 2020. The fifth section focuses on internal structure and synergy with other EU programmes, and the sixth and final section deals with future directions.

3.4 DEMA's approach to risk and vulnerability for civil contingency planning

The Danish version of the report is the Danish National Vulnerability Evaluation (National Sårbarhedsudredning); the English version referred to here is a short summary entitled DEMA's Approach to Risk and Vulnerability Analysis for Civil Contingency Planning, prepared in 2005. DEMA (Beredskabstyrelsen) is the Danish equivalent of MSB in Sweden. The purpose of the report was to present a national-level risk analysis applicable to the following seven sectors of Danish society:

- Fire & Rescue: local fire & rescue services

- Maritime safety and security: harbour authorities

- Energy: electricity and natural gas suppliers

- Banking & finance: the Danish Central Bank

- Safety & security: Danish Police Intelligence

- Public health: the National Centre for Biological Defence

- Communication and technology: the National IT and Telecom Agency

The report contains detailed analyses and models for each of these seven operational sectors in Denmark, including rationale, methodological and operational basis and broad scope of potential applications of the national risk evaluation. The report is broad in scope, offering an overview and new knowledge in relation to potential threats as a reliable basis for decision making. The aim is to facilitate effective communication and multidisciplinary work on preparedness, better coordination between authorities, and sound legislation in relation to threat exposures, and to assist in structuring training exercises.

3.4.1 Data

The report states that the data used were comprehensive and qualitative in nature to facilitate broader understanding at a generic level, with familiar terminology that is easy to grasp and in use across various operational sectors. The data are also scenario-based, focusing on team procedures and multidisciplinary work processes in cases of societal-level crisis. While the report offers no further detail on how these elaborate and comprehensive data were collected, it identifies the source as the National Intelligence Police of Denmark.

3.4.2 Method

The method adopted here is based on Preliminary Hazard Analysis (PrHA), which is simple, easy to understand and can be utilized across all sectors by practitioners who need not be experts in hazard analysis. Another significant advantage of PrHA is that it requires no sophisticated technical or statistical data for the purposes of evaluation. Instead, the process involves small group meetings and workshops, with field inspections where applicable. DEMA's use of PrHA also reflects an 'all hazards' approach, planning for civil contingencies

related to risks and hazards of various types in different sectors of Danish society.

To keep the method and evaluation simple and easy to understand, delivery was electronic. Respondents were asked short questions based on selection of options, with open texts to explain their choices. Other techniques included dropdown menus and checklists, and focus groups were used to complete the evaluation.

3.4.3 Limitations

Although the report is comprehensive and its method and analysis are easy to understand, one of its main limitations is the lack of visualization of data and distributions, which means that interconnections between different categories of risks, threats or hazards remain unclear.

3.5 DSB national risk regimes, Norway

This is a national level report prepared for Norway by the DSB (the Norwegian Directorate for Civil Protection) in 2014 as a national-level risk analysis or NRA, based on several risk and vulnerability assessments (RVAs). While the report assesses the likelihood of various types of threat or risk, data on serious, rare events such as malicious acts, terrorist attacks or cyber threats are largely unavailable due to the unexpected nature of such events. For that reason, the NRA bases likelihood and threat assessments for such events on Norway's foreign and national security policy as of 2014.

3.5.1 Data

The NRA uses qualitative and quantitative risk analyses based on expert assessments. Although likelihood and impact are quantified, no overall risk acceptance is specified for each of these types of serious event or risk. This also means that there is no general acceptance of risk that can be uniformly applied across sectors, and the acceptable limit of risk for each category of risk or threat for each sector was determined by expert panels. The NRA examines a series of scenarios that would be considered serious societal events with disastrous effects on Norwegian society, focusing on three types or categories of risk: natural events, major accidents and malicious acts. These risk categories are described in more detail in the Method section below.

The NRA drew on a range of different data. To begin, expert assessment and agreement through workshops and seminars accessed historical data from several government departments. Qualitative assessments were performed to define and describe uncertainty assessments, quality of knowledge base assessments, and the quantitative basis for likelihood assessments. These historical data were both qualitative and quantitative, and can be broadly classified as survey data, GIS data and policy reports. Following expert evaluation of this knowledge base, the seminars and workshops produced descriptions and definitions of consequence, likelihood and uncertainty assessments. Finally, consequences or losses for each risk scenario were quantitatively estimated, based on historical knowledge and projected damage.

The experts also took account of individual risk perception data, which were quantitatively assessed and combined with historical data to agree on qualitative descriptions and risk acceptance. Finally, a risk matrix was constructed, based on both qualitative and quantitative assessments.

3.5.2 Method

As noted earlier, the NRA analysis employs scenarios for each category, making a clear choice to analyse only those events that are neither everyday nor 'extremely unimaginable'. The report utilizes a likelihood-consequence graph, clearly showing the selected category in graphical form. From administrative, resource planning and organizational perspectives, the report delineates three distinct levels of governance in Norway: national/ state level at the top, county level in the middle and local level at the bottom. Catastrophic events are characterised as those that affect county level and require national-level planning. As such events are not confined to one sector but are likely to affect all sectors at county level, a national-level overview and planning is justified.

3.5.2.1 Steps to NRA
In preparing the NRA, there were four distinct steps:

- Definition of societal assets to be protected for consequence assessment

- Identification of adverse events and development of scenarios

- Risk analysis of the scenarios

- Presentation of risk analysis results

Defining the societal assets to be protected provides an essential basis for consequence assessment and commonly determines the extent of analysis and planning. In other words, a consequence assessment is performed for each risk category and corresponding scenarios on the basis of these definitions.

As well as consequence assessments, there are also likelihood assessments of selected scenarios, which together with a risk matrix are formulated by expert assessment and agreement. Expert assessments are an integral part of NRA, entailing several rounds of expert interviews, seminars and workshops in the preparation of the NRA, risk categories, consequence assessment definitions for holistic analysis and likelihood assessments. One of the principal motivations for DSB's expert interviews and seminars is the value of interdisciplinary knowledge and rich analysis. NRA draws inspiration from risk assessments abroad and uses expert assessments to identify risk acceptance levels in each risk category or scenario. Finally, the combination of expert interviews with historical data and policy analysis compensates for the low reliability of individual risk perception data for quantitative analysis.

The NRA identified the following set of indicators to determine the quality and sensitivity of data and the validity of the uncertainty assessment:

- Access to relevant data and experience: Comprehension of the event being assessed—for example, how well known and researched is the phenomenon in question, and how much agreement is there among the participating experts?

- Sensitivity of the results: Answers questions such as the extent to which a change in expert assumptions affects likelihoods and consequences.

- Overall assessment of uncertainty.

Finally, a risk matrix was prepared to specify the scenario and to assess its likelihood and consequences.

3.5.3 Limitations

The method adopted here seems to have good reliability and validity. The NRA is based on holistic and comprehensive data collection with triangulation of data, using a range of methods such as expert assessments, policy analysis, seminars and workshops. However, one major drawback is the lack of visualization of relations between risk categories. In addition, there is no singular map using GIS data for all risk categories to highlight which geographical areas of Norway are considered most likely to experience such scenarios. It can be concluded that these assessments and analysis focus on consequence, impact and likelihood assessment to assess various losses and to plan accordingly for civil contingencies and national security. A geographical distribution of risks highlighting any vulnerable zones would be of greater use for resource allocation and budgeting purposes.

3.6 National progress report on the implementation of the Hyogo framework for action, Norway

This national level report progresses strategic frameworks, policies and evaluation towards a holistic measure of DRR (disaster risk reduction) in Norway. The report was prepared in 2015 by the Norwegian Ministry at national level, along with the Directorate of Civil Protection and Emergency Planning at the Ministry of Justice and Public Security. (It should be noted that an interim report was prepared by the same authority in 2011.) The purpose of this report was to assess existing DRR measures in Norway based on indicators identified by the Hygo Framework for Action (HFA). The primary strategic goals of the progress report were actions on climate change, actions to facilitate emergency preparedness, land use planning and DRR policies and actions for comprehensive RVA (risk and vulnerability analysis) at all levels of government, including national level.

3.6.1 Data

The data are mainly survey-based, with qualitative descriptions. According to the report and survey, 85% of Norwegian municipalities have employed a comprehensive approach to RVA, but the minimum standards for RVA have been met by only 30%. The report also states that only 30% of Norwegian municipalities have an emergency preparedness plan. Most of this progress report is based on DBS's National Risk Regimes, which is a comprehensive RVA employed by the Directorate of Civil Protection and Emergency Planning. Section 2.2.4 above details DSB data types and data collection.

3.6.2 Method

The report uses the following core indicators, with short descriptions and qualitative text indicating the stage of progress, including some recommendations.

- Climate change indicator: This includes qualitative descriptions of measures in relation to floods, landslides and building infrastructure at each level of government. The qualitative description also indicates availability of funds for implementation of such measures at each level.

- DRR plans and activities indicator: The qualitative description indicates operational capacities at various levels of government, enabling their integration for better cooperation, coordination and overall operational capacity. This also indicates any unavailability of information on budget allocation.

- Community participation and decentralization indicator: The description indicates whether legislation and policy frameworks are in place with a DRR mandate, and whether there is a regular budget allocation for such activities. This indicator is largely defined by RVA as performed by DSB.

- Multi-hazard risk assessment indicator: The description includes future probable risks of serious unexpected events (see section 2.2.4 of the RVA by DSB).

- Early warning system indicator: The description lists the different types of early warning system in place for different types of hazard, such as extreme weather, flood risk and landslide. It also describes the accessibility of risk distribution data from the DSB and other information systems operated by the Directorate of Norwegian Water and Energy Resources (NVE).

- Training and education practice indicator: The description includes components of DRR training and education practices, both at government planning level and in school, college and university curricula.

- Research methods and tools for multi-risk assessment indicator: This description lists research programs and projects such as H 2020 that focus on DRR to facilitate new knowledge and practices in DRR for better adaptation.

- Economic and social development indicator: This description contains a list of societal level insurance systems such as crop insurance, health insurance and business insurance.

- Gender equality perspective indicator: This description is not elaborated, although United Nations development reports rank Norway highest for gender equality perspectives.

- Preparedness and contingency plans indicator: This description consists mainly of recommendations and ongoing work from

municipality to national level on coordination, resource planning and preparedness.

3.6.3 Limitations

The document refers to the DSB RVA and other reports for details of method and data sources, which are not adequately documented in this report. Although the method of indicating progress through selected list of indicators and their descriptions by answering yes/no questions makes the report easy to understand and provides a generic overview, there is a need for more transparency in terms of how the conclusions were drawn and any additional methods of verification. Although the indicators are themselves quite strong, they fail to capture interconnections, which means that associated risks and disaster risk reduction measures in various sectors cannot be clarified. However, the list of selected indicators of progress on DRR activities and strategic planning provides a useful overview of areas of application of comprehensive risk data, basis for recommendation and areas of improvement.

3.7 A national risk assessment for Finland

Prepared by the Ministry of Interior in Finland, this national-level report was published in 2016, with contributions from all government departments. The NRA is the result of European Parliament legislation in 2015 requiring the development of holistic risk assessments for various domains for emergency planning and the overall safety of citizens. The NRA mentions at the outset that the aim of the report is to safeguard civil protection. This is the first NRA prepared by Finland.

3.7.1 Data

The report uses definitions and descriptions but provides no details on how these were derived. However, it is clear from the report that these are nationally accepted definitions in Finland for emergency planning and risk assessment for civil protection.

The data were drawn from individual risk assessments performed by various actors and departments in Finland at local level. All of these individual risk assessment data are combined to construct the NRA framework.

3.7.2 Method

Using a multi-stakeholder approach, more than 60 risk cards based on individual risk assessments identified the top risks for each branch or department. On the basis of impact and likelihoods, 21 scenarios were identified for the purposes of the NRA. These scenarios were developed by various branches with the help of internal writing groups and working groups, with the additional support of expert opinion and consultation as required.

The selected scenarios were divided into two categories. The first of these comprised wide range events affecting society, whose probability is difficult to estimate and which depend on multiple factors, making it extremely challenging to assess their impact. The second category included occurrences whose likelihood and impact are easier to estimate. Although regional in

character, these may be of such magnitude as to warrant a request for international assistance.

While initial observations focused mainly on individual risks, worst-case or most probable scenarios were also considered subsequently. The NRA report categorizes each key scenario by likelihood of occurrence and impacts. While likelihood estimates are based on statistical and historical records, impact is measured on the following indicators.

Human impact

- Fatalities

- Injured

- Evacuated

Economic impact

- Material loss (in Euro)

- Consequential loss (in Euro)

Environmental impact

- Extent of damage (in square km)

- Duration

Societal impact

- Critical infrastructure (number)

- Duration

- Vital functions (number)

- Duration

3.7.3 Limitations

The report provides sufficient and interesting detail on scenario building. However, it misses the compound effects across risk categories and scenarios in terms of risk connections that could be derived from MVA and PCA meta-analysis. It also fails to capture GIS data to build scenarios other than in the case of natural hazards. The report mentions that all branches and departments were free to engage in expert consultations in their working and writing groups. However, it does not mention whether any department opted for such consultations, and if so, which ones, and how their analysis may have differed from others. The report also fails to elaborate on how nationally accepted definitions and descriptions were derived across various departments and levels of government.

3.8 A risk assessment for Iceland; global, societal and military factors

This report was prepared in March 2009 by a Commission appointed by the Icelandic Ministry of Foreign Affairs, comprising an expert panel of 13 members from academia, business and practice. The aim of the report was to provide a broad definition and description of types of risks and threats for use in framing policy decisions related to risk and national security issues. The report was also intended to support risk assessment and analysis in relation to various aspects of civil society.

3.8.1 Data

The appointed panel of experts used both qualitative and quantitative data. The report does not clarify the methods of data collection, stating only that data were retrieved from historical records held by the Ministry that are relevant and applicable in various departments.

3.8.2 Method

In establishing the rationale, the report opens with a historical background, referring to the US (NATO) presence in Iceland for geopolitical, diplomatic and strategic reasons dating back to the Cold War and because of increasing current concerns about national security. It also elaborates on the financial crisis faced by Iceland following the economic meltdown in 2008 and discusses how the combined effect of these changing scenarios compelled the Icelandic government to develop a comprehensive approach to risk assessment and definition of societal risk. The methodology of the report makes it clear that rather than an NRA for emergency planning and preparedness, the aim and scope of this risk report by the Icelandic Foreign Ministry is to develop accepted definitions and descriptions, to raise risk awareness and to assess perceptions of different types of risk.

Because of the wide variety and existing differences in impacts, the report does not prioritize or rank risk categories. However, each is defined and described, with a short summary of threats from each of these risks from the perspective of Iceland's national security and civil protection. The report concludes with recommendations steps to be taken by the Icelandic Ministry to address the relevant threats for each category of risk from a national security perspective. For example, it offers clear recommendations on fruitful types of risk assessment/ analyses for sectors such as energy, transportation, communication, banking and finance both in terms of national security and financial stress. Another recommendation is that the Ministry should retrieve demographic data for a population register that clearly records Icelandic nationals abroad to facilitate communication with them in times of national emergency.

3.8.3 Limitations

Although the report contains detailed descriptions, one of its major limitations is the absence of detail about the types of data collected or how those data were collected, mentioning only that the expert panel of 13 members arrived at these

definitions during meetings. Another limitation of the report is the lack of visualization of data to denote distribution. As the report is qualitative, it contains no matrix or code to define the distribution or probable impact of each of the identified risk categories.

3.9 National risk assessment in Iceland

The first national risk assessment for Iceland was conducted between 2008 and 2011, and this report was published in 2011. While a preceding report was prepared by the Department of Foreign Affairs (Icelandic Foreign Ministry), the current report discussed here was prepared by the Department of Civil Protection and Emergency Management, and Office of the National Commissioner of the Icelandic Police. The report comprises risk assessments for all of Iceland's 15 civil protection districts and 74 municipalities. Its main purpose was to formulate contingency and emergency plans for all of Iceland's administrative units, following national legislation and a directive in 2008. The scope of the report was to overview hazards using an 'all hazards' approach and to utilize the results for mitigation measures, preparedness, community resilience and emergency planning.

3.9.1 Data

The data on which the report was based were retrieved from historical records in the civil protection districts. Each civil protection district also utilized this data to prepare their own response and contingency plans at district level. A similar process was followed at national level, collecting all risk assessments from Iceland's civil protection districts for collaborative preparation of a national plan. In conjunction with available historical data, expert discussions also made an important contribution to specifying the acceptable limits of risk categories. These discussions involved experts from various sectors, who worked with the civil protection districts on the preparation of the NRA.

GIS data were used in the preparation of scenarios and the determination of acceptable limits of risk categories, especially with regard to geothermal risk. As Iceland is a centre of geothermal resources, GIS data inputs proved helpful not only in preparing the NRA and assessing potential risks and hazards but also in deciding on provisions such as early warning systems and housing regulations in specific high-risk geographic locations, such as those affected by volcanic eruptions and volcanic ash. In summary, such data provide the envisaged support for location-specific mitigation measures and preparedness, as well as scenario building for emergency plans.

3.9.2 Method

The 'all hazards' approach used here is applicable at both local and national level. The method draws on the Joint Australian/New Zealand standard AS/NZS-4360-2004 Risk Management. The model works more like a guide, providing a generic framework for managing risk. To assess the level of risk associated with various threats, the Icelandic NRA also used risk and vulnerability methods (RVA and ROS) widely used at local level by several countries in Scandinavia, including Sweden.

All 22 of Iceland's civil protection districts came together to form the National Committee for the NRA. Using expert interviews and discussions, the Committee derived acceptable definitions of risk, hazard, threat and identification of risk categories. A similar process was used to derive acceptable levels of risks in each identified risk category. The impact or consequence was assessed on the basis of the four qualitative indicators, which are listed below, along with their definitions and rank or level of severity. Consequences were rated from 1 ('insignificant consequence') to 5 ('extreme consequence').

- Extreme:
    - Lives and health of population (indicator): Many fatalities and serious injuries, catastrophic direct/extremely large indirect effects on health and lives
    - Environment (indicator): Catastrophic damage to the environment—long-term and permanent
    - Economic value (indicator): Catastrophic damage to property
    - Social values and function of society (indicator): Ongoing mistrust of social institutions and general instability, extreme disruptions in societal functionality

- Critical
    - Lives and health of population (indicator): Extremely large direct or significant indirect effects on health
    - Environment (indicator): Extremely serious damage to environment, long-term effect
    - Economic value (indicator): Extremely serious damage to property
    - Social values and function of society (indicator): Extremely serious disruptions in societal functionality, continued distrust of social institutions and changed behaviour

- Major
    - Lives and health of population (indicator): Significant direct or moderate serious effects on health
    - Environment (indicator): Serious short-term damage to the environment
    - Environment (indicator): Serious damage to property
    - Economic value (indicator): Disruptions in societal functionality, continued mistrust of several social institutions and changed behavior

- Minor

    o Lives and health of population (indicator): Moderate direct effects on health and lives

    o Environment (indicator): Limited damage to the environment—little effect

    o Environment (indicator): Limited damage to property

    o Economic value (indicator): Limited disruptions to societal functionality, transient mistrust of several social institutions

- Insignificant

    o Lives and health of population (indicator): Small direct effects on health and lives

    o Environment (indicator): Extremely limited damage to environment

    o Environment (indicator): Extremely limited damage to property

    o Economic value (indicator): Extremely limited disruptions to societal functionality

In addition, the risks in each category were assessed in terms of likelihood, vulnerability and capability. Likelihoods were again assessed on a scale of 1 ('very unlikely or rare') to 5 ('extremely likely or almost certain').[1] Each risk was assigned a number based on these indicators, and a risk matrix was prepared for all risk categories. GIS images were prepared for all identified climate and geothermal risks to depict the extent of damage in graphical form.

3.9.3 Limitations

One of the main limitations of the report is that while referring to and providing indicators of consequent damage, the methodology does not disclose the quantitative basis for these indicators, especially with regard to economic loss. Instead, the report refers back to qualitative definitions derived from expert definitions and the acceptable limits within each risk category. For that reason, it remains unclear what quantitative basis might underpin those qualitative descriptions, or indeed whether there is any such quantitative basis.

As Iceland is especially exposed to certain climatic and geothermal hazards, GIS data would be very useful in identifying areas of natural hazard, in conjunction with information on the interconnectedness of hazard risk categories, especially in the context of mitigation and preparedness. Although Iceland's current NRA uses GIS data inputs, it does not elaborate on the

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[1] Very high probability (almost certain): more than 10 times a year; High probability (likely): 1–10 times a year; Medium probability (moderate): once every 10–50 years; Low probability (unlikely): once every 50–1000 years; Very unlikely (rare): once every > 1000 years.

interconnectedness of hazard risk categories. Like many of the other NRA reports discussed here, this can be considered a major limitation.

3.10 Ireland risk report: A national risk assessment for Ireland

This report was submitted by the Government of Ireland's Office of Emergency Planning in 2012. It was prepared by the DCU Business School, with inputs and data from various local government departments and State agencies. The report was finally approved by the Special Task Force, which is responsible for national-level emergency planning. The report aims to define and describe hazards, impacts, risks and likelihood of societal importance to Ireland that could be utilized to develop a national risk assessment. It organizes those hazards and risks into various categories and a risk matrix for overall assessment.

3.10.1   Data

The data used were mainly historical in nature and were retrieved from relevant local government departments that collaborated in the report's preparation. However, there were significant gaps in some of the risk categories, where historical data were not relevant. In such cases, the DCU Business School's panel of academic experts, officers from government departments and state agencies conducted focused groups to formulate a description, level of threat, definition, impact, and likelihood for such risk categories. Examples include the civil risk category, which includes terrorist activity, and high and low temperatures in the natural hazard risk category, as Ireland's climate is highly influenced by Atlantic currents.

Current changes and fluctuations in climate have a significant effect on Ireland's weather and climate and pose a significant risk. As climate change and its associated risks or impacts are measurable only in a limited way at present, the experts' group discussions and historical data were combined to estimate risk, level of threat, impact and likelihood. These descriptions were qualitative in nature; for the purposes of a risk matrix, figures were assigned— again through focus groups and matching of trends from domestic historical data and relevant data, reports and policies from neighbouring countries.

In the civil hazard risk category of terrorist activity, Ireland has not yet faced any major threat or consequence of this kind. However, given changes in diplomatic relations and measures taken by its neighbours in terms of national security and policies to combat such terrorist threats, the experts agreed definitions, descriptions, acceptable limits of threat, impacts and likelihood of this risk for the purposes of the NRA.

3.10.2   Method

Focus group discussions were used for hazard identification and assessment of societal impact and likelihood, along with definitions and agreed level of acceptance of risk in each category. The impact of the worst-case scenario was assessed on a scale from 1 ('very low') to 5 ('very high'). The assessment was based on four indicators (Life, health & welfare; Environment; Infrastructure; and Social).The indicators were further refined by such measures as number of

fatalities, extent of geographical area affected and so on. For example, a very low impact of 1 is characterised as follows:

- Life, health and welfare: Limited number of people affected; 0–4 fatalities; limited number of minor injuries requiring first aid treatment

- Environment: Simple, localized contamination

- Infrastructure: < 4M Euros

- Social: Localized disruption to community services or infrastructure (< 48 hours)

Alternatively, a very high impact of 5 is characterised by the following:

- Life, health and welfare: Large numbers of people impacted, with significant numbers of fatalities (> 50), significant injuries in the hundreds, and more than 16,000 evacuated

- Environment: Very heavy contamination, widespread effects of extended duration

- Infrastructure: > 200M Euros

- Social: Serious damage to infrastructure causing significant disruption to or loss of key services for prolonged period; community unable to function without significant support

Likelihood is also assessed and ranked from 1 ('extremely unlikely') to 5 ('extremely likely') and defined as follows.

- Extremely unlikely: May occur only in exceptional circumstances once every 500 or more years

- Very unlikely: Not expected to occur *and/or* no recorded incidents or anecdotal evidence *and/or* very few incidents in associated organizations, facilities or communicates *and/or* little opportunity, reason or means to occur; may occur once every 100–500 years

- Unlikely: May occur at some time *and/or* few, infrequent, random recorded incidents or little anecdotal evidence; some incidents in associated or comparable organizations worldwide; some opportunity, reason or means to occur; may occur once per 10–100 years

- Likely: Likely to or may occur; regular recorded incidents and strong anecdotal evidence; will probably occur once per 1–10 years

- Very likely: Very likely to occur; high level of recorded incidents *and/or* strong anecdotal evidence; will probably occur more than once a year

Based on the above definitions, a national risk matrix was prepared, with likelihood and consequences for each risk category. The hazards under each risk category assessed for the NRA were as follows.

- Natural: Floods, droughts, snow, volcanic ash, storm, high temperatures, low temperatures

- Transport: Air, maritime, road, rail, transport hub

- Technological: Disruption to energy supply, industrial incidents, fire, nuclear (abroad), cyber incident, radiation (domestic)

- Civil: Infectious disease such as pandemic, terrorist activity, loss of critical infrastructure, foodborne outbreaks, waterborne outbreaks, animal diseases, crowd safety incidents, public disorder

Finally, a national risk matrix was prepared, depicting all the above hazards in the various risk categories in terms of their likelihood and impact, as the final output of Ireland's NRA.

3.10.3   Limitations

One of the limitations of Ireland's NRA report is the categorization and motivation behind 'loss of critical infrastructure' under the civil hazard risk category, which is also depicted as an indicator of impact assessment under each hazard risk category. Such a categorization may be confusing as a methodological framework. Secondly, as in many other NRA reports, Ireland makes little use of MVA or PCA, which might be helpful in assessing the strength of relationships or interconnectedness of different hazard risk categories, which could contribute significantly to contingency or emergency planning on a national level. Ireland's NRA also fails to provide any scenario-specific simulation or exercise under each hazard risk or threat category, as quite elaborately performed in Norway's DSB National Risk Regimes. This means that Ireland's NRA was confined to historical accounts, data and expert discussions, with the final output of the risk matrix depicting all hazard risk categories, which further implies that no hazard risk out of that risk matrix has been included in the NRA. The NRA does not mention the inclusiveness of the hazard risk categories, although it notes that the risk categories were again derived from expert discussions and historical data. The NRA notes that worst-case scenarios were included for each hazard risk category but fails to elaborate on the involvement of different levels of government—for example, whether a particular hazard risk threat is expected to involve the local, county or national level of government. Finally, the NRA also fails to provide any indication of the geographical extent of expected impacts or consequences—for example, no GIS maps were included in the report to further specify the qualitative definitions. The report also fails to comment on whether such GIS maps were utilized in preparing the NRA.

3.11 UK risk report: A national risk assessment for UK

Published in 2015, the National Risk Register of Civil Emergencies (NRR) is the unclassified version of the National Risk Assessment (NRA), a classified assessment of the risks of civil emergencies facing the UK over the next five years. The NRR is a public resource for individuals and organizations seeking to be better prepared for emergencies. It should be noted that the UK's NRA is a classified document, and no further details are available concerning which departments at national level were involved at Cabinet level in preparing the NRR and NRA.

3.11.1 Data and methods

The NRR reveals that data collection and the methodology used for the NRA was based on expert consultations for risk identification, categorization, assessment of impact and likelihood and predetermined definitions and descriptions of risk, as well as the acceptable limits of risk. Risk matrices were also prepared by means of these expert consultations.

It should be noted that the NRR and NRA consider only risk categories with short-term impacts—more precisely, those that may have a severe impact within five years—so excluding from their risk matrices long-term risks such as technological advances, climate change or antimicrobial resistance. However, the NRR mentions that the NRA plans to include these long-term impact threats in future following collection of 'better evidence' (although the NRR does not specify what is meant by this term).

Short-term severe impacts are assessed on the basis of the following indicators: Fatalities, Illness or injury; Social disruption; Inability to gain access to emergency services (healthcare etc.); Economic harm and Psychological impact.

The NRR/NRA conclusions aim to provide a basis for contingency plans and local resilience forum (LRF) action plans.

3.11.2 Limitations

The report fails to provide sufficient detail for a comparative critical summary. Nevertheless, the fact that the NRA/NRR provides a basis for short-term emergency planning applicable at local level may indicate that these risk categories and methodology are also relevant at local levels.

4. Explorative analysis of risk positions: An example

This section illustrates how a quantitative explorative Multiple Correspondence Analysis (MCA) can provide a better understanding of the entangled relations between risk and other power relations such as gender, class and race, as well as their intersections (Giritli Nygren, Öhman and Olofsson 2016). Here we explore possible risk positions in Sweden related to risk attitudes and behaviour using data from the Survey of Risk and Society (SRS), a Swedish national survey conducted during the autumn of 2011.[2] The survey included a total of 280 questions, drawing on the SRS surveys of 2005 and 2008 and other earlier studies (e.g. Olofsson et al. 2014; Sjöberg 2000). The survey addressed a range of questions, including political orientation, income, social support, risk perception, risk behaviour and experience of crises of various kinds. To measure specific risk perception, eighteen questions were asked about different kinds of risk (e.g. *How big is the risk for you personally to suffer from: e.g. smoking, accidental fall, illnesses etc.*). Similarly, eight questions were asked about risk behaviour (e.g. *How often do you: e.g. smoke, have unprotected sex, walk home alone at night*). (For a detailed description, see Table A in the Appendix.) The survey also collected extensive socioeconomic data about respondents; of these, gender, background and social class were used in the analysis. Gender was measured as being a woman or man; background was based on place of birth of oneself or one's parents (Sweden, the Nordic countries, Europe/North America/Australia, or Africa/Asia/South America); and social class was measured in terms of income, divided into three categories. Gender, background and class were also combined, creating intersecting assemblages. (For a detailed description, see Tables B and C in the Appendix.)

MCA enables analysis of relationships among several categorical variables by means of standard correspondence analysis on a matrix whose entries are 0 or 1 (Abdi and Valentin 2007). MCA produces dimensions that individually explain some of the variance in the variable matrix, which are also visualized as two dimensional 'maps' or 'spaces', where the dimension that explains most variance is combined with the X-number of additional dimensions (Veenstra

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[2] The dataset used in the analyses is composed of two representative samples of the Swedish population between the ages of 16 and 75; A national random sample of all inhabitants in Sweden (n = 2500; response rate 41%), and a random sample of people living in three districts in Stockholm, Gothenburg and Malmö (n = 1000, response rate 25 %). In total, 1078 people completed the questionnaire. The purpose of the second sample was to increase the number of people of foreign background in the dataset. Because of language problems and incomplete or inaccurate addresses, the response rate among people with foreign backgrounds was expected to be low.

2011). Researchers commonly limit the number of dimensions to make interpretation easier, based on explained variance and interpretation.

As already mentioned, this example analyses the relationship between risk perceptions, risk behaviour and sociodemographic stratification, together creating risk positions. In combination with the constructs of gender, background and class, the assemblages were entered as 'inactive' or supplementary variables—that is, they were not used to compute the dimensions but were overlaid on the existing space (Veestra 2011).[3]

4.1 Three dimensions

Before turning to the analysis, the social space will be briefly introduced, along with the identified dimensions based on the relationships between the information provided by the respondents in the study as included in the analysis.[4] As three-dimensional spaces are difficult to present graphically on paper, the three dimensions must be *pictured* as two two-dimensional spaces; here, we have opted to present dimensions 1 and 3 as an example of how to picture the space as two-dimensional. Figure 1 presents the risk attitudes and risk behaviours used to form the space to convey how the space is formed and how the different axes are interpreted and labelled.

Based on the choice of variables, two sets of related questions within a predefined frame (perceptions and behaviour) and the shape of the space constituting the dimensions were more or less anticipated. The first dimension accounts for approximately 26% of the total variance of the social space and is characterised by 'high- and low-risk perception'. Looking at the space, it is quite clear that high-risk perception (regardless of the kind of risk) is represented on the left side of the vertical dimension while the other end of the dimension is characterised by low-risk perception. The second dimension, represented by a vertical axis, accounts for approximately 13% of the total variance of the social space. (The graph is not included in the report.) This dimension is interpreted as representing an 'In-between concern' because, in the upper half of the graph, we find risk perception responses that are neither

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3 In the analysis, missing values were not substituted to avoid bias; instead, cases with missing data were excluded. As a result, 261 of 1094 cases were excluded from the analyses, leaving 833 analysed cases. There are disadvantages in excluding cases from the analysis, as this may create bias if the excluded the cases are not randomly selected but have certain characteristics. On the other hand, methods of estimating missing responses also have limitations. Here, 900 cases responded to all items, so providing a reliable dataset.

4 Based on an evaluation of eigenvalues and explained variance, three dimensions (or axes) of the MCA constituted the basis for analyses. These three dimensions account for approximately 50% of the variance among the variables inserted in the model and together create a three-dimensional space. Beyond the third dimension, the amount of variance attributable to subsequent dimensions are small and the difference between them (based on the eigenvalues) is insignificant. For a more thorough description and deeper analysis of the dimensions and the space they create, see Öhman, Giritli Nygren and Olofsson (forthcoming).

high nor low but in-between. The third dimension is also represented by a vertical axis (see Figure 1); this accounts for approximately 8% of the total variance of the information and has been labelled 'risk behaviour'. It is characterised by responses claiming low risk-taking behaviour in the upper half of the graph and high risk-taking behaviour in the lower half.
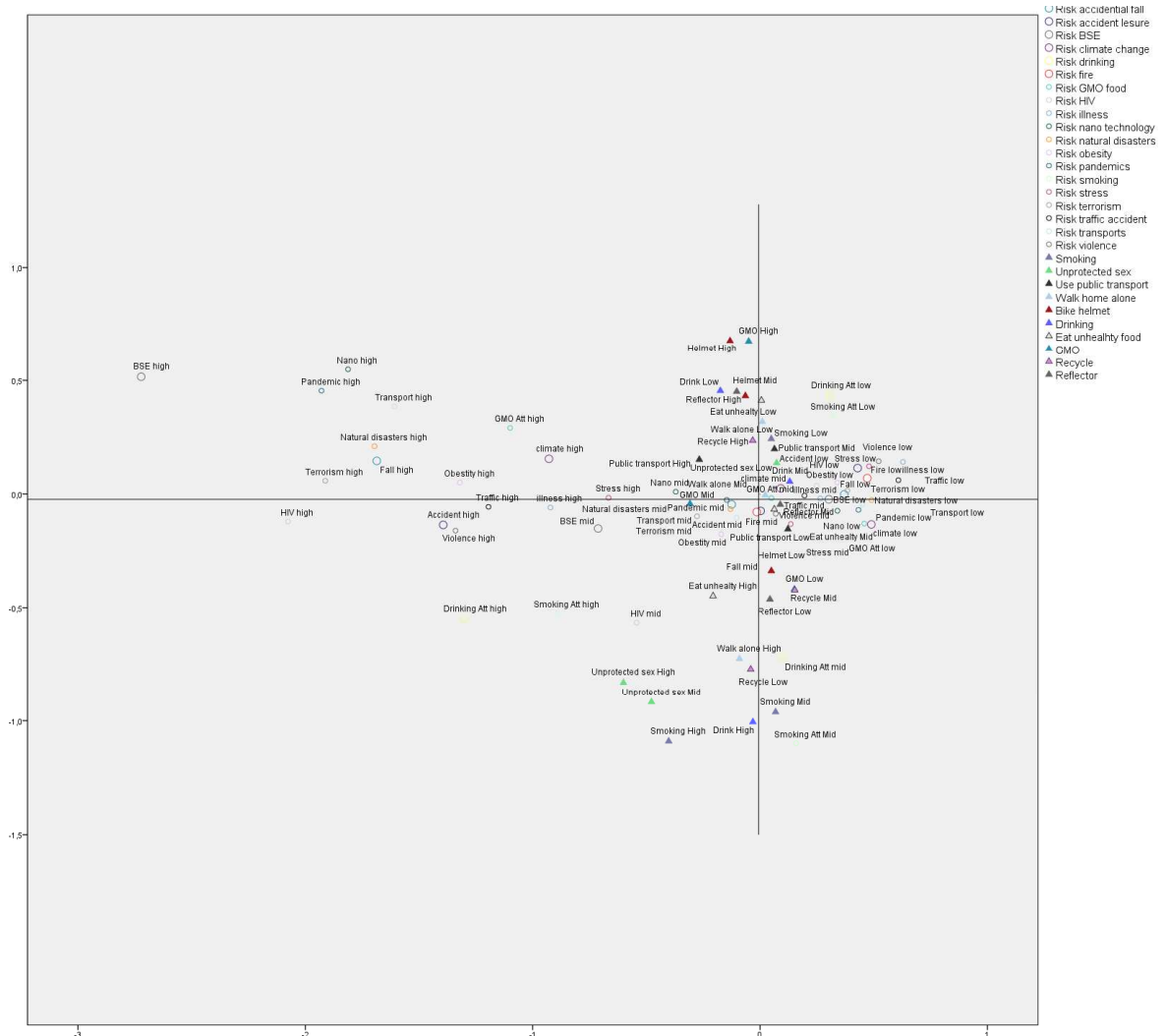

Figure 1. Multiple Correspondence Analysis of core dimensions 1 and 3: high and low risk perception (horizontal axis) and risk behaviour (vertical axis).

In the following sections, the space will be explored using an intersectional risk approach (see Giritli Nygren, Öhman and Olofsson 2016). To make interpretation easier for the reader, Figure 2 shows gender, background, class and their assemblages plotted in the space formed by risk perceptions and risk behaviours.

4.1.1   Risk positions

Turning to the intersectional analyses and what happens to the three-dimensional space when analysing the assemblages of gender, background and class, it is possible to analyse how risk perception and behaviour is entangled with subordination and privilege.

Joint Plot of Category Points
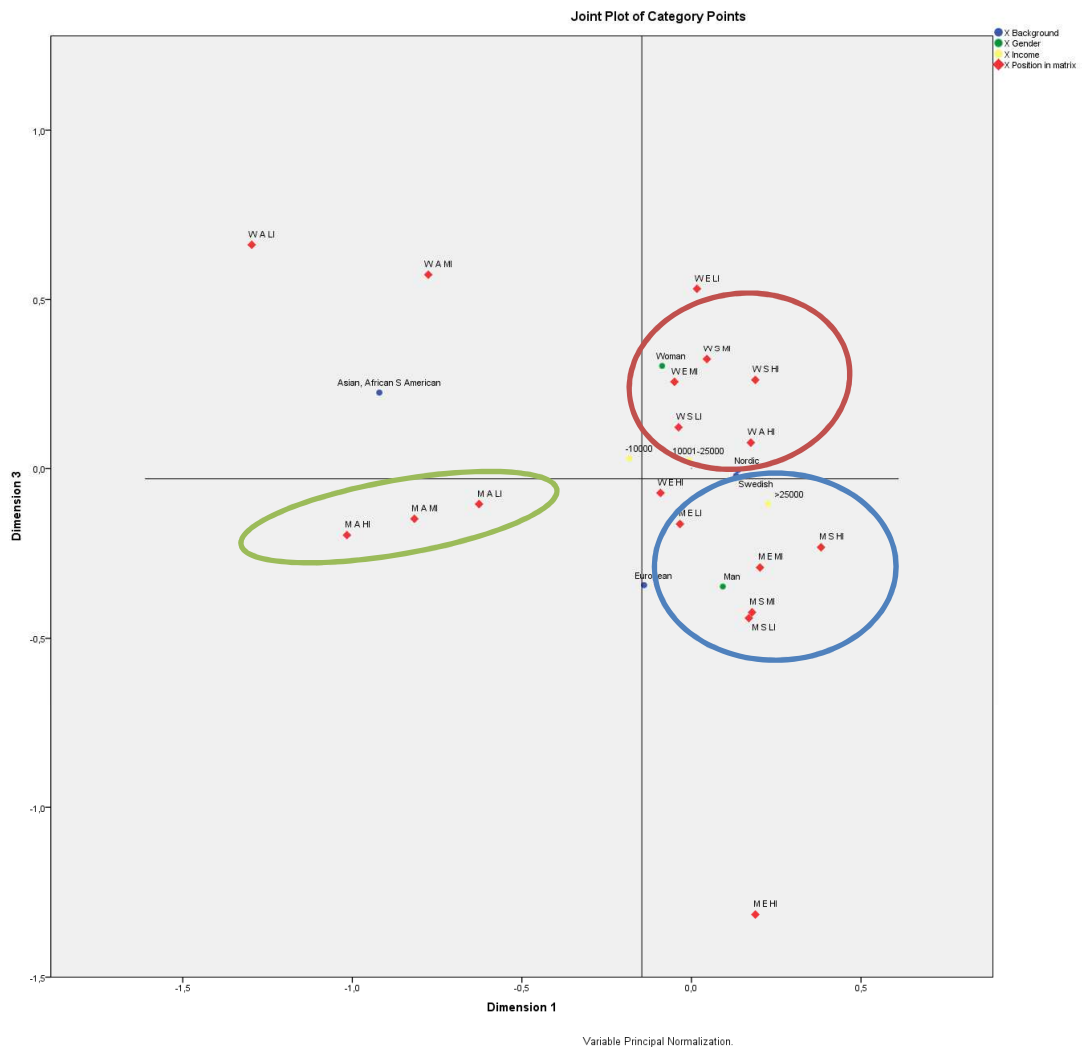
Variable Principal Normalization.

Figure 2. Multiple Correspondence Analysis of core dimensions 1 and 3: high and low risk perception (horizontal axis) and risk behaviour (vertical axis) where the intersectional assemblages are included as inactive elements.

Looking first at the single categories, although only for educational purposes, we find that women and men are quite far apart, with women indicating fewer risk behaviours than men. Looking at background (measured as place of origin), we find that a Swedish background renders a low-risk perception position; in contrast, being born in or having family ties to Africa, Asia or South America results in almost the opposite position of high-risk perceptions. A European background is associated with the risk behaviour dimension, indicating low-risk behaviour. Finally, class (represented by income) shows a linear relationship, in which low income is associated with higher risk perception and high income with low-risk perception.

Turning to the assemblages, a somewhat different picture emerges. In Figure 2, we highlighted three clusters of assemblages with three circles. The orange circle is located in the upper right square, an area characterised by low-risk behaviour and low-risk perception, which could be described as a 'safe space'. The cluster is all-female and comprises women of different backgrounds. A closer look reveals that all assemblages, including Swedish women, are found here, but only high-income women from a non-European background and

middle-income European women are positioned in this area. In this 'safe space', we find two other assemblages that include European women but no male assemblages or assemblages with people from a non-European background. The blue circle is located in the lower right square, an area represented by low-risk perception and high-risk behaviour—a 'risk taking space'. This cluster is composed of assemblages of men of Swedish and European background. Although this cluster is in the risk-taking space, all of these assemblages are still quite close to the 'safe space'. The third cluster, marked with the grey circle, is located in the lower left square, an area characterised by high-risk perception and risk taking. In this cluster, we find assemblages of men of non-European background. Interestingly, unlike other high-income assemblages, which tend to be positioned close to the low-risk perception end of the first dimension, we find the opposite here. The clusters indicate differences in risk positions that are gendered, classed and ethnified. Although these results are both interesting and important, these clusters are fairly homogeneous. We therefore turn our attention to some of the assemblages that break the pattern. High-income women of non-European background and women of Swedish background are similarly positioned, and high-income men of European background are found in a position of high-risk taking, far from all other assemblages.

These examples illustrate the potential of MCA in terms of intersectionally analysing risk positions and demonstrate how incomplete that knowledge would be if only single categories were analysed. Using MCA, it is possible to analyse assemblages of gender, background, class and risk positions within social spaces defined by risk perception and risk behaviour. For example, it is possible to trace the privileged position of a Swedish male high-income earner and to contrast this with the position of, for instance, a male high-income earner from outside Europe in terms of risk position.

5. Summary and conclusion

Looking first at the single categories, although only for educational purposes, we find that women and men are quite far apart, with women indicating fewer risk behaviours than men. Looking at background (measured as place of origin), we find that a Swedish background renders a low-risk perception position; in contrast, being born in or having family ties to Africa, Asia or South America results in almost the opposite position of high-risk perceptions. A European background is associated with the risk behaviour dimension, indicating low-risk behaviour. Finally, class (represented by income) shows a linear relationship, in which low income is associated with higher risk perception and high income with low-risk perception.

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Appendix 1: Tables

Table A. Questions included in the analyses and descriptions of re-codings where applicable

Survey item or variable		Answering alternative	Recoding
Risk perceptions Smoking Alcohol HIV Climate change Fire GMO Transportation Natural disasters Violence	BSE Technological systems Accidents (leisure time) Terrorism Stress Epidemics Cancer Traffic accidents Obesity Accidental fall	Scale ranging from 1 (very small) to 5 (very big)	1(1-2) low 2(3) mid 3(4-5) high
Risk behaviour How often do you do the following? Drink alcohol Smoke Eat unhealthy food Have unprotecting sex Walk home alone at night	Avoid GMO foodstuff Use public transport because of the environment Recycle Use bike helmet Use reflex	Scale ranging from 1 (never) to 5 (very often)	1(1-2) low 2(3) mid 3(4-5) high

Table B. Questions added to the analyses and descriptions of re-codings where applicable

Survey item and Label used in the analyses	Answering alternative	Recoding
Background[5] Where were you born? Where was your mother born? Where was your father born?	Sweden Nordic country Europe/North America Africa, Asia, South America	Sweden Nordic country Europe/North America Africa, Asia, South America
Gender	Man Woman	
Income Net income?	0-900 901-10000 10001-15000 15001-20000 20001-25000 25001-30000 30001-35000 >35000	Low (0-10000) Middle (10001-25000) High (>25000)

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[5] This new variable is named 'Background' because it includes not only where the respondent was born but also where her/his parents were born. If the respondent and/or at least one of his/her parents were born outside Sweden, this country was deemed dominant.

Table C. **Construction of assemblages of gender, income (representing class) and background (representing ethnicity)**

Gender	Background	Class/Income	Assemblage Acronyms
Women (W)	Sweden (S)	Low Income (LI)	W S LI
Women (W)	Sweden (S)	Middle Income (MI)	W S MI
Women (W)	Sweden (S)	High Income (HI)	W S HI
Men (M)	Sweden (S)	Low Income (LI)	M S LI
Men (M)	Sweden (S)	Middle Income (MI)	M S MI
Men (M)	Sweden (S)	High Income (HI)	M S HI
Women (W)	Europe (E)	Low Income (LI)	W E LI
Women (W)	Europe (E)	Middle Income (MI)	W E MI
Women (W)	Europe (E)	High Income (HI)	W E HI
Men (M)	Europe (E)	Low Income (LI)	M E LI
Men (M)	Europe (E)	Middle Income (MI)	M E MI
Men (M)	Europe (E)	High Income (HI)	M E HI
Women (W)	Africa, Asia, South America (A)	Low Income (LI)	W A LI
Women (W)	Africa, Asia, South America (A)	Middle Income (MI)	W A MI
Women (W)	Africa, Asia, South America (A)	High Income (HI)	W A HI
Men (M)	Africa, Asia, South America (A)	Low Income(LI)	M A LI
Men (M)	Africa, Asia, South America (A)	Middle Income (MI)	M A MI
Men (M)	Africa, Asia, South America (A)	High Income (HI)	M A HI