



Swedish Civil
Contingencies
Agency

Swedish National Risk Assessment 2012



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Swedish Civil Contingencies Agency (MSB)

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Foreword

The national risk assessment is part of the process of developing our collective capacity to prevent and manage extensive and adverse events at all levels of society.

Sweden's first national risk assessment is a more in-depth study and further development of the risk identification conducted in 2011. It comprises the work of municipalities and county councils, county administrative boards and other public authorities; however, the Swedish Civil Contingencies Agency, MSB, is also responsible for securing complementary analyses which are not performed by these organisations. The national risk assessment has also been developed as part of an EU cooperation, and is based on common guidelines for the Member States which aim to create opportunities for increased collaboration and the exchange of experience in this field.

The purpose of the risk assessment is to create a common understanding of serious risks in Sweden and future consensus on proposed measures and resource priorities. A national risk assessment also requires analyses of emergency management capability. However such analyses and proposals for measures linked to the national risk assessment are yet to be developed.

This report, Swedish National Risk Assessment 2012, will lend support to the joint task of developing civil protection and emergency preparedness at a local and regional level – including for private organisations that perform vital societal functions – as well as the development of Sweden's capacity to cope with large-scale accidents and crises in collaboration with other countries. The report illustrates the importance of complementing the capacity to cope with more frequently occurring incidents with the ability to prevent and manage unusual events which have more extensive impacts, regardless of the accuracy of the assessments on which the work is based.

MSB has sought transparency in methodological issues and extensive stakeholder participation. The quality of the assessments, uncertainty assessments, is a key development area and provides an indication of the issues that need to be investigated more closely with other parties.

In the national risk assessment, MSB has been in contact with 56 governmental agencies, 16 municipalities, 3 county councils and 14 other organisations. A great number of people have contributed as experts and key figures in identifying, selecting and analysing events thus far.

Many thanks to all those who, in various ways, contributed to this report on Sweden's first national risk assessment. Your participation is essential in our continuing effort to create a resilient society in a changing world.

Helena Lindberg
Director-General

The Swedish Civil Contingencies Agency

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Executive Summary

Executive Summary

In Sweden, as in other countries, the development of more informed assessments of the various major risks that society as a whole is facing, as well as of its capacity to prevent, manage and recover from serious incidents and events, has long been viewed as desirable. The idea is that national risk and capability assessments, may facilitate coordination, prioritisation and the building of consensus in a country's system of emergency preparedness.

The Government of Sweden has commissioned the Swedish Civil Contingencies Agency (MSB) to continue the work of producing a national risk assessment that began in 2011. MSB has also initiated work to develop a more coherent and reliable process for producing national risk and capability assessments.

As a result of the National Risk Assessment 2012, MSB has

- identified 27 particularly serious (national) events, which are primarily derived from the more than 200 events identified in the agencies' risk and vulnerability analyses of 2010–2011,
- developed eleven scenarios based on a selection of these events,
- analysed and assessed seven scenarios,
- developed a procedure and methodology for national risk assessments in Sweden,
- documented the stakeholders' experiences of participating in the analysis.

The seven analysed scenarios include:

- extensive disruption to GNSS (Global Navigation Satellite Systems),
- a school shooting,
- disruption to the drinking water supply due to diesel discharge in Stockholm's raw water,
- disruption in the food supply due to fuel shortages,
- a major fire on a cruise ship,
- the failure of a large dam on a river, and
- a prolonged heat wave.

MSB has assessed the annual likelihood of each of these events occurring in Sweden, as well as the impacts of the event occurring in accordance with the scenario. In addition, MSB has assessed the degree of uncertainty in these likelihood and impact assessments. Of seven events above, the MSB has concluded that *a school shooting* and *a prolonged heat wave* are the most likely to occur. *Extensive disruption to GNSS* and *disruption to the drinking water supply due to diesel discharge in Stockholm's raw water* are deemed to be the two events least likely to occur.

A major fire on a cruise ship, disruption in the food supply due to fuel shortages and the failure of a large dam on a river are, according to MSB's assessment, the events from the selection that would have the greatest impacts. This implies that these events would cause greater harm to human life and health, economy and environment, or political and social functions, than the other events. *Disruption to the drinking water supply due to diesel discharge in Stockholm's raw water* is the event judged to have the least impacts.

The greatest risks, i.e. the events with the highest values when combining the likelihood, impacts and uncertainty, are *fuel shortage leading to disruption in the food*

supply, failure of a large dam on a river and prolonged heat wave. At the same time, the assessments of *a prolonged heat wave* and *extensive disruption to GNSS* have the highest degree of uncertainty. This means that there are very few statistics and little data on which to base the assessments and that the margin for error is significant. It is not possible to establish that these seven events represent the greatest risks facing Swedish society, due, in part, to the fact that scenario development and analysis have yet to be conducted for a number of the 27 events that MSB has assessed as particularly serious in the agencies' risk and vulnerability analyses. This is also a reason why the risk assessment still cannot be used as a basis for prioritising the measures that are to be taken.

Scenarios have also been developed for an additional four events: *pandemic caused by the influenza virus A/H5N1* (avian influenza virus), *nuclear disaster with radioactive discharge*, *terrorist attack in the City of Stockholm*, and *the spread of social unrest and riots in Sweden*. Through an analysis of these scenarios and further scenario development, the number of analyses will gradually be expanded over the next few years.

The risk assessment represents a distinctly developmental initiative that is largely based on the European Commission's Risk Assessment and Mapping Guidelines for Disaster Management (2010). MSB has sought to involve as many emergency management stakeholders as possible, and in its communication with them, openly accounts for the difficulties and choices involved in methodology issues. The identification of events for further analysis, as well as scenario analyses, has been carried out jointly with a large number of experts and key figures from different agencies, sectors and levels of the Swedish civil contingencies system. MSB's evaluations show that the workshop participants appreciated the method used for risk assessment and have used it as inspiration for their own activities. They also state that the workshops have helped them make valuable contacts and given them a deeper understanding of the complexity of events, as well as of inter-dependencies and vulnerabilities in the response to emergencies. Nevertheless, the process and methodology developed and tested in 2012 require improvement and additional development.

Efforts to integrate risk and capability assessments

Over the next few years, MSB intends to create a coherent process and uniform methodology for national risk and capability assessments. The goal is for the risk and vulnerability analyses of civil contingencies organisations to be designed so that they contribute more to risk and capability assessments at the national level, and that the national assessment, in turn, constitutes support for the risk and vulnerability analyses.

This requires that the current system be revised in terms of both content and design. For example, a basic methodology is required for capability assessments, including a clearly defined concept of capability with specified empirical indicators. The national risk assessment needs to incorporate a more long-term perspective, as well as more types of complex events. It is also necessary to develop the methodology for societal cost-benefit analysis, not least to improve the assessment of impacts and facilitate the composition of a proposal that indicates the measures that should be taken.

Background

1. Background

1.1 The Swedish Context

The Swedish system of civil contingencies involves all levels of governance (local, regional and central) and is fundamentally based on the principles of *responsibility*, *parity* and *proximity*; which means that:

- agencies that are responsible for providing particular services under normal circumstances maintain this responsibility in an emergency,
- the ways in which public services function in an emergency should, as far as possible, be the same as under normal circumstances, and
- an emergency should be handled where it occurs, by those immediately affected and responsible.

The principal task of the Swedish Civil Contingencies Agency (MSB) is to enhance the emergency management capacity of Swedish society, mainly by supporting and guiding the actions of the organisations concerned. In accordance with national law, governmental agencies, county councils and municipalities have, since the early 2000s, regularly carried out, so called, risk and vulnerability analyses.¹ These analyses include an assessment of the agency's capability to deal with a specific scenario, as decided by MSB. For the past six years, MSB and its predecessor (Krisberedskapsmyndigheten – the Swedish Emergency Management Agency) have published overall assessments of Sweden's emergency management capability, based, primarily, on these local, regional and sectorial risk and vulnerability analyses. However, for various reasons, these assessments do not equate to a *national risk assessment* as outlined in the European Commission's Risk Assessment and Mapping Guidelines for Disaster Management (2010).

The risk and vulnerability analyses are self-assessments, essentially aiming to facilitate the emergency preparedness planning of the organisations that are performing them. From a national perspective, they are inevitably limited in scope by geography or subject matter, relative to the entire field of civil protection. In 2010, MSB issued regulations (MSBFS 2010:6 and MSBFS 2010:7) the purpose of which is to increase the comparability and transparency of these analyses. Yet, the methods used in conducting them may vary considerably and key concepts are in need of more precise definitions.

Consequently, until recently, there was no established method for systematically selecting, analysing and evaluating hazards at the national level in Sweden. When, in 2011, MSB was commissioned to produce a national risk assessment for the first time, the agency faced the challenge of both developing such a method and carrying out the actual assessment.² Risk and vulnerability analyses conducted by Sweden's many emergency management stakeholders have also played a significant role in this work, but merely as a basis for the identification of potential risks.³ Unlike MSB's

1. The Emergency Management and Heightened Alert Ordinance (2006:942) has, since 2002, obliged central government agencies to conduct such analyses every year; while, since 2006, municipalities and county councils are required to do so every four years under the Act on municipal and county council measures prior to and during extra-ordinary events in peacetime and during periods of heightened alert (2006:544).

2. In 2011, MSB carried out a risk identification based on risk and vulnerability analyses by Swedish emergency management stakeholders as a first step in the development of a national risk assessment. By that time, however, the process and methodology for this type of risk assessment was incomplete. Thus, in 2012, the previous risk identification was reviewed as part of the national risk assessment.

3. In identifying potential risks, the National Risk Assessment 2012, risk and vulnerability analyses from 2010 and 2011.

previous assessments of Sweden's emergency management capability, the National Risk Assessment 2012 included methodologically coherent scenario analyses in which experts and stakeholders representing different sectors, levels and disciplines of the civil contingencies system were engaged. In the Swedish context, such an integrated, comprehensive approach is a novelty.

Thus, until now, MSB's recurring overall assessments of Sweden's emergency management capability and the national risk assessment have constituted separate processes. In practice, however, risks and capabilities are closely interlinked. A complete risk assessment requires some form of capability assessment and vice versa.⁴

MSB's ambition for the future, therefore, is to develop an integrated national risk and capability assessment.

1.1.1 The Swedish assessment of 2012 in relation to the European Commission's guidelines

The Swedish National Risk Assessment 2012 corresponds to a government commission which explicitly refers to the Council of the European Union's conclusions of 2011 on further developing risk assessment for disaster management within the European Union (8068/11).⁵ The conclusions provided an important basis for this work, along with the 2010 European Commission Staff Working Paper *Risk Assessment and Mapping Guidelines for Disaster Management*.

In accordance with these guidelines, three categories of impacts (human, economic/environmental and political/social impacts) are used in the joint analysis of risks in this report. However, as further explained in section 2.2 (*General process and methodology*) five such categories were used in the Swedish assessment of 2012.

The Swedish impact categories are identical to the, so called, protection values that MSB has established with respect to, among other things, Sweden's safety objectives (Government of Sweden, Skr. 2009/10:124). Two of the five Swedish categories – *human life and health* and *economic values and the environment* – correspond exactly to the guidelines' categories *human impacts* and *economic and environmental impacts*. Of the other Swedish categories – *society's functionality, democracy, rule of law and human rights and freedoms*, and *national sovereignty* – the first two partly match the third category in the guidelines, *political/Social impacts*. The Swedish category *national sovereignty* relates mainly to threats and events that fall outside the intended scope of the guidelines.⁶

The scenarios developed thus far are based on single incidents or multiple events in chains of cause and effect. Risk mapping constitutes part of the supporting data for one scenario (*failure of a large dam on a river*) but is still lacking in other areas.

The analysed scenarios are compiled in a risk matrix. Complementary to the model proposed in the Commission's guidelines, the Swedish matrix illustrates the degree of aggregated uncertainty in the assessments of the scenarios' likelihood and impacts.

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4. The estimated impact of a disaster forms part of the concept of risk, and to some extent this impact depends, in turn, on the capability of those affected to resist or cope with the disaster. Capabilities, on the other hand, are demonstrated in real emergencies and must otherwise be assessed in relation to estimated risks in one way or another.
 5. The Government of Sweden's appropriations directives concerning the Swedish Civil Contingencies Agency 2011 and 2012, respectively.
 6. MSB chose to establish national sovereignty as a protection value/category after following the example of other countries' national risk assessments.

The Swedish assessment will include eleven to fifteen analysed scenarios over the two-year period of 2012–2013. Taking into account that this is Sweden's first national risk assessment, this is in accordance with the number of scenario analyses recommended in the guidelines.

The National Risk Assessment 2012 lacks a risk evaluation, i.e. an assessment of whether risks and/or their magnitude are acceptable, since a method for this type of analysis has yet to be developed. For this reason and others, the risk matrix for 2012 is not suitable as material for decision-making or prioritisation, nor does the risk assessment include recommendations concerning policy measures.

Finally, the longer time perspective (25–35 years), remains to be introduced in Sweden's national risk assessments.

1.1.2 Participants and valuable contacts

The Swedish National Risk Assessment 2012 has involved many stakeholders. Fifty six government agencies, 16 municipalities and 3 county councils appointed liaison officers for this assignment. A number of other agencies, trade organisations and individual researchers have also contributed their expertise in various ways.

On 19 March 2012, emergency management representatives from the transport sector participated in a workshop on the proposed methodology for the national risk assessment. On 25 April, MSB ran a workshop on the identification and selection of risks, involving representatives from 29 agencies. MSB has held information sessions for emergency management stakeholders and a series of internal workshops that focused on issues of methodological development.

Seven scenarios were analysed in 2012, and six of these were analysed mainly through a workshop. An additional four scenarios were developed for future analysis. The goal for the coming years is to develop and analyse three to four additional scenarios which are based on the 27 national events that were identified in 2012.

The number of scenarios that MSB is capable of analysing in one year, while attaining a satisfactory quality, is determined by a range of factors. MSB has sought to achieve a high level of transparency and participation of other stakeholders in the Swedish civil contingencies system. The analysis of most scenarios has critically included workshops involving experts and other key individuals. Such workshops are particularly valuable in analyses for which supporting data are scarce or inadequate. They also provide an important forum for discussion between experts of different areas. During the workshops, new issues relevant to the risk assessment are often identified, which implies that thorough research is required both before and after these events. In addition, many experts are engaged in other MSB-related assignments and their availability is thus limited.

The Swedish risk assessment 2012 was also inspired by national risk assessments and methodology reports from Norway, the United Kingdom, Netherlands, Canada and Germany. MSB has enjoyed an extensive exchange with the Directorate for Civil Protection and Emergency Planning (DSB) in Norway.

1.1.3 Aim

The aim of the Swedish national risk assessment is to create a common understanding of serious risks in Sweden, and eventually, through proposing measures and priorities, to provide guidance for national emergency preparedness for a safer society.

Delimitations

Incidents and events that occur and impact Sweden outside the country's boundaries (such as natural disasters in locations where many people permanently residing in Sweden are staying temporarily) have, thus far, not been included in the national risk assessment.⁷

1.1.4 Key concepts

National protection values and national level

Civil protection and emergency preparedness aims to safeguard certain values. The comprehensive protection values that have been established for the national risk assessment are:

- human life and health
- society's functionality
- democracy, rule of law and human rights and freedoms
- economy and environment
- national sovereignty.⁸

The protection values are national in the sense that they are relevant at all levels of society and the civil contingencies system, (i.e. that they are also relevant at the local level). The risk assessment deals with events that have serious impacts at the national level. This means that the incident in question must meet the criteria for both a *crisis in society* and a *national event*:

A *crisis in society* refers to an event that:

- affects many people,
- affects a significant proportion of society,
- threatens fundamental values and functions,
- cannot be managed with normal resources and organisation,
- is out of the ordinary and/or
- requires concerted action by several stakeholders.⁹

A *national event* refers to an incident that has one or more of the following impacts:

- Human impact: approximately 30 people dead or seriously injured.
- Economic/environmental impact: direct costs (destruction of property) of approximately SEK 750 million.¹⁰
- Political/social impact: circumstances deemed to be very serious, for example, with regard to:
 - how people have been killed,
 - how powerless the victims were in relation to the incident,
 - who is responsible,

7. However, causes in the analysed scenarios may entirely or partially originate outside of Sweden's national borders, such as in the scenario *Fuel shortage leading to disruptions in the food supply*.

8. The first three protection values correspond to the objectives for Swedish safety in accordance with Government Communication 2009/10:124, *Society's crisis preparedness – Strong collaboration for increased safety*. The other two values – *economy and environment and national sovereignty* – have been added with regard to how impacts are categorised in the EU's guidelines (2010) as well as other countries' national risk assessments. The protection values were established by MSB Management on 19 March 2012.

9. Skr. 2009/10:124 *Society's crisis preparedness – Strong collaboration for increased safety*.

10. i.e. the same magnitude as resulting from the storm "Per" (2007).

- political fallout,
- if the event gives rise to great civil unrest, or
- if the nation’s leadership comes under threat.¹¹

Consequently, a national event, in this sense, need not be an event which has extensive impacts in geographical terms. For example, an event that affects only a few municipalities, may still be considered national due to there being significant numbers of deceased or injured and significant direct costs.

Risk and risk level

The national risk assessment is based on MSB’s definition of risk as the “...weighing together of the likelihood that an incident will occur and the (negative) impacts that this could conceivably have”.¹² This definition is in harmony with the European Commission’s guidelines and ISO standard 31010, under which risk is a combination of an event’s impacts and the likelihood that it will occur. In Sweden’s national risk assessment, *uncertainty* with regard to impacts and likelihood is, therefore, considered as an integrated part of the term risk.

Thus, ‘risk level’ refers to a combined assessment of the likelihood of an event and its impacts, as well as the uncertainty in previous assessments. The level cannot be derived solely from an event’s position in the risk matrix (where the y and x axes represent impact and likelihood respectively). When two events are of equal value in terms of combined likelihood and impact, but differ with respect to uncertainty, the event with the highest uncertainty is deemed to be the greater risk.

Uncertainty

In this context, the term uncertainty refers to the type of knowledge that exists about a particular event and how reliable this knowledge is as a basis for assessing the likelihood that the event will occur, as well as its impacts, should the event actually occur. Uncertainty may thus refer to the assessment of likelihood and/or the assessment of impacts.

General event

A general event refers to a hypothetical event (that historically may have occurred) for which context-forming variables such as place, time (season, day of week, time of day), weather etc., have not been specified. It is only the *type* of event that is being referred to, e.g. a “shipping accident”.

Scenario

A scenario refers to a hypothetical event for which variables such as place, time, weather etc., and their values have been specified. The national risk assessment is based on 22 scenario variables (see Appendix 2), all of which need not be relevant for every scenario. Therefore, there is some variation in the number of variables per scenario.¹³ In other words, a scenario is a unique combination of specified variables. If the value of a scenario variable is changed, the scenario is no longer the same, but has become a different – albeit similar – scenario.

11. The term *national event* was coined in the National Risk Assessment 2012 with the EU’s guidelines (2010) as the primary model.

12. MSB, Guide to Risk and vulnerability analyses, MSB 245, April 2011, p. 78.

13. Conversely, there may be assumptions about material factors that are specific for certain scenarios, such as the chemical composition of oil in the case of an oil spill at sea.

2. Results of the National Risk Assessment 2012

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The National Risk Assessment 2012 has resulted in:

- the identification of 27 national events on the basis of authorities' risk and vulnerability analyses, 2010–2011,
- eleven scenarios based on these events,
- analyses and assessments of seven events,
- the process and methodology developed in order to conduct the assessment, and
- the emergency management stakeholders' and MSB's documented experiences of this work.

The seven events in question have been assessed in terms of impacts, likelihood and the degree of uncertainty in these assessments. They have been compiled in a risk matrix that will gradually be supplemented with assessments of additional scenarios.

As a general principle, MSB strives, in the national risk assessment, to incrementally select and analyse events based on the magnitude of the risk they represent. However, an event may be selected for scenario development and analysis on grounds other than likelihood and impact assessments, e.g. if it has not previously been examined in detail from a civil contingencies perspective.

2.1 Analyses and assessments of seven events

2.1.1 Scenario development based on 27 national events

Developing and working with scenarios plays an important role, with regard to exercises and prevention, within the field of civil protection and emergency preparedness. For risk assessment, it is necessary to develop scenarios, as the assessment of an event's impacts becomes dubious or completely arbitrary if it lacks established variables and variable values. At the same time, the development of a scenario means that the likelihood of that particular scenario occurring becomes lower than for the more general event on which the scenario is based.¹⁴

MSB has initially compiled a selection of 200 events, based primarily on the risk and vulnerability analyses carried out by Swedish emergency management stakeholders in 2010 and 2011, which were assessed in relation to the national protection values. This resulted in a selection of approximately 40 unique events, which were then roughly assessed with respect to likelihood, impacts and uncertainty. The 40 general events were also analysed against the criteria for a national event, which 27 events were ultimately judged to meet.

The eleven scenarios that were developed in the National Risk Assessment 2012 were built on these 27 general events, including the seven scenarios that have been analysed thus far. At the final selection stage before the 2012 scenario development, six events were rejected for various reasons.¹⁵ Otherwise, the number of general events was

14. For example, the likelihood that all or part of Sweden, within a certain time period, will be hit by a severe heat wave is obviously higher than that of a specific region in Sweden being affected.

15. Sulphur mist, landslide, and ice storm were rejected after taking into account assessments of likelihood and/or impacts. Contaminated drinking water supply (biological contamination) was rejected on the grounds that an identical event with another cause (chemical spill) was included. Theft of false information and armed aggression were rejected for reasons related to definition.

reduced through 15 of the 27 events (Figure 1 below, left column) being merged into seven new events, while six events (school shooting, heat wave, fire in protected objects, nuclear accident, social unrest with violent element and storm) remained unchanged (Figure 1, centre column). MSB then chose to save two events for later scenario development.¹⁶ The scenarios do not necessarily involve *greater risks* than the general events from which they originate. For example, the likelihood of scenarios built on composite general events occurring is lower than that of the individual events.¹⁷

The order in which the 11 developed scenarios are analysed is arbitrary, i.e. the seven scenarios analysed in 2012 were not ranked by way of any risk assessment in relation to the four scenarios that remain to be analysed. The possibility cannot be excluded that significant events may have been overlooked in the risk identification phase. So far, no events that occur outside the country's boundaries and impact Sweden have been included in the national risk assessment.

In other words, MSB does not consider the seven scenarios analysed in 2012 to represent the greatest risks facing Sweden as a country. They should, instead, be viewed as in-depth studies of a selection of the 27 events which were considered to be particularly serious in the risk identification phase.

2.1.2 Considerations in developing the scenarios

The national risk assessment relates to, among other things, events that have low likelihood but that could have serious impacts if they do occur. Events that are national, or become national, usually take place in a particular municipality or region, or affect certain localities to a disproportionately high degree. Given that a national risk assessment encompasses the whole of society and all societal levels, the eleven scenarios, which have thus far been developed, have, as much as is possible, been situated in different locations in Sweden.

In the process of scenario development, it was ensured that each of the eleven scenarios have impacts that threaten at least one national protection value and that, when taken together, they include threats to all of the protection values. They are also designed to be of the *worst probable* type, which means that, unlike *worst case* scenarios, they may result in significant or very significant impacts and be considered realistic on the basis of expert knowledge in the field to which the scenario pertains.¹⁸

In addition, the scenarios have been designed, as much as is possible, to challenge different parts of the Swedish civil contingencies system. The National Risk Assessment 2012 is meant to constitute a basis for the discussion of the risks facing Sweden. It can be seen as complementing other work within the area, such as crisis management exercises, scenario analyses, capability assessments and risk and vulnerability analyses.

16. *Disruptions in electronic communications/solar storm and storm* were kept in order to limit the number of scenarios in the first round of scenario development. In the case of these events, scenarios need to be developed and analysed in the coming years.

17. The likelihood of any type of pandemic occurring is higher than the likelihood of one specific pandemic caused by avian influenza occurring. Conversely, the likelihood for some form of contagious animal disease (epizootic) to spread is higher than that of a pandemic resulting specifically from avian influenza.

18. i.e. that the likelihood of the scenario should not be so low that it is basically non-existent. A *worst case scenario* rarely takes into account that the scenario may occur, and is often based on society's capacity to handle the scenario being completely eliminated.

Figure 1: Overview - from 27 general events to 11 scenarios.

X=rejected events from the 2012 assessment, XX=Events that were not chosen as the basis for scenarios in 2012 but which need to be developed into scenarios for analysis in future years,
XXX=Scenarios which were developed in 2012 but have not yet been analysed

27 general events (national events)	13 events, of which 7 were created by merging formerly individual events	11 Scenarios
Disruptions in transportation	Disruptions in transportation	Fuel shortage leading to disruptions in the food supply
Disruptions in the fuel supply	Disruptions in the fuel supply	
Disruptions in the food supply	Disruptions in the food supply	
Disruptions in electricity supply	Disruptions in electricity supply	Dam failure in a large river dam
Dam failure	Dam failure	
Flooding of watercourses	Flooding of watercourses	
School shooting	School shooting	School shooting
Contaminated drinking water supply (chemical spill)	Contaminated drinking water supply	Disruptions in the drinking water supply due to diesel in Stockholm's raw water
Ship collision	Ship collision	
Heat wave	Heat wave	Prolonged heat wave
Fire in protected objects	Fire in protected objects	Major fire on a cruise ship
Disruptions in electronic communications	Disruptions in electronic communications	Extensive disruptions in GNSS
Space debris	Space debris	
Solar storm	Disruptions in electronic communications Solar storm XX	
Pandemic	Pandemic	Pandemic scenario caused by influenza virus A/H5N1 (avian influenza virus) XXX
Epizootic (widespread dispersal of contagious animal disease)	Epizootic	
Nuclear accident	Nuclear accident	Nuclear disaster with radioactive discharge XXX
Social unrest with violent element	Social unrest with violent element	Spread of social unrest and riots in Sweden XXX
Act of terrorism (Utøya, Bryggaregatan)	Act of terrorism	Terrorist attack in the City of Stockholm – bombs at Sergels torg and T-centralen (Central Station) XXX
Chemical dispersal via a bomb	Chemical dispersal via a bomb	
Ice storm X		
Theft of/false information X		
Landslide X		
Sulphur mist X		
Storm	Storm XX	
Contaminated drinking water supply (biological contamination) X		
Armed aggression X		

2.1.3 Risk matrix for the National Risk Assessment 2012

In accordance with the European Commission's guidelines (2010), the assessed scenarios are presented in a risk matrix, i.e. a graphic device for illustrating and comparing different risks.

How events are positioned in the matrix, crucially depends on the knowledge base of the underlying assessments. Therefore, more in-depth analyses can lead to other assessments in the future. The current analyses were conducted in slightly different ways due to variations between the areas concerned with regard to the quality of knowledge. Consequently, it is very difficult to make reliable comparisons between the events. This deficiency can, however, be reduced over time as the analysis is developed further.

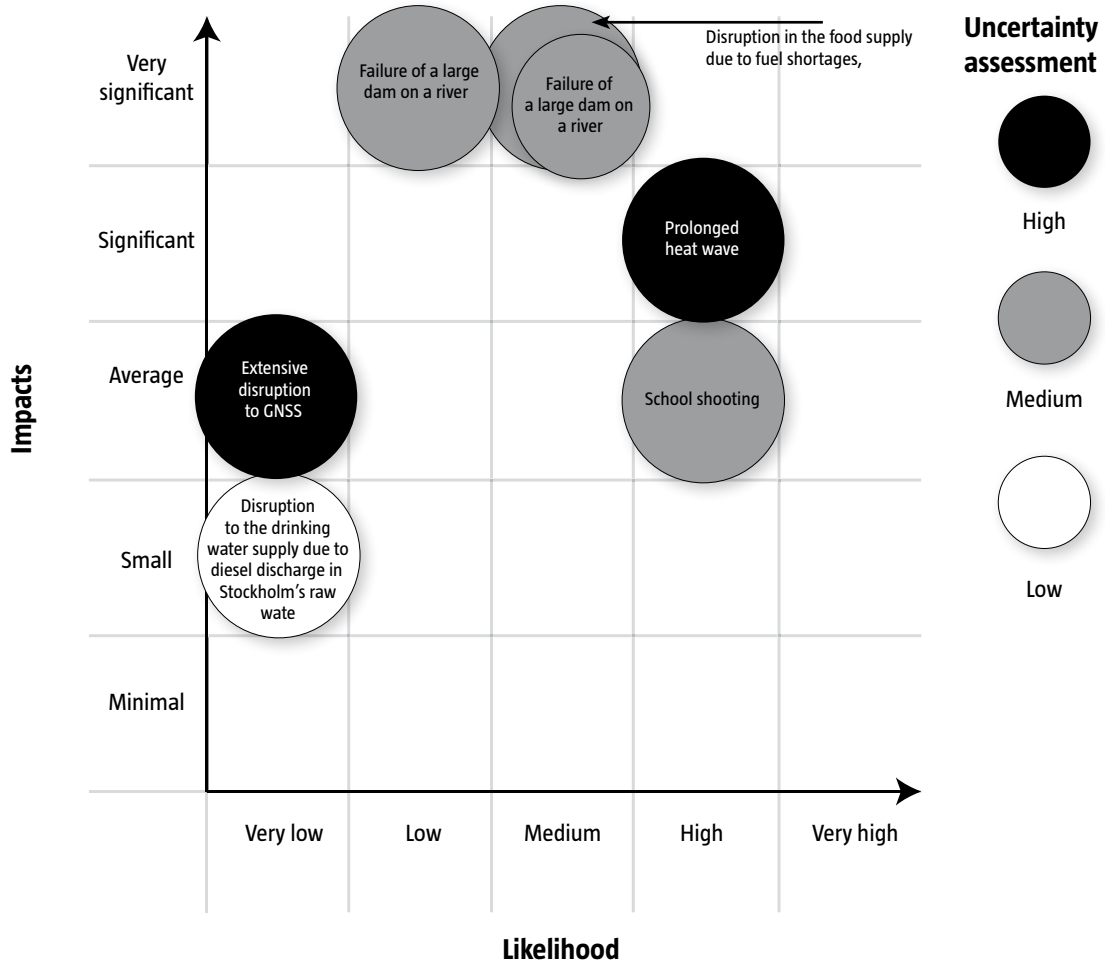
The risk matrix provides an overview of the combined assessment carried out in terms of likelihood, impact and uncertainty (of the likelihood and impact assessments) for each event. This so called '5x5 matrix', consists of five columns and five rows with 25 possible combinations of likelihood and impact (Figure 2).

The likelihood assessments for each event in the matrix indicate the likelihood of an event *similar* to the analysed scenario occurring in Sweden within one year. The reason for this is that, from a *national* emergency preparedness perspective, it is often more relevant to assess the likelihood of a serious event occurring in the country as a whole within a given timeframe, than assessing the likelihood of a serious event occurring at a particular location in the country.¹⁹ The impact assessments, however, indicate the impacts of the very scenario that has been analysed (see Chapter 3, Scenario analyses 2012).

Impact assessments are thus scenario-specific, while likelihood assessments are general, with the exception of the scenario *disruption to the drinking water supply due to diesel in Stockholm's raw water*. For this scenario, it was also necessary in the likelihood assessment to define a specific geographical area, as the technical capacity to handle diesel discharge in the raw water resources varies considerably across the country.

19. For example, the scenario *failure of a large dam on a river* assumes a dam failure in Ljusnan, while the likelihood assessment refers to the likelihood that there is a breach in one of the 20 dams in Sweden where a dam failure could have such extensive impacts as in the scenario. However, impacts are location-specific, for example, in terms of how many people are living downstream of the dam and the infrastructure found there. In the analysis, it is still possible to draw some general conclusions regarding impacts, particularly in terms of *what type of impacts* an event would yield.

Figure 2: Risk matrix for the analysed scenarios in the National Risk Assessment 2012. Note that MSB does not necessarily consider these events to be the greatest risks facing Sweden today.



The risk matrix's qualitative scales for likelihood and impact assessment, respectively, have quantitative indicators, with the exception of political and social impacts which are only described in qualitative terms (Figures 3 & 4).

Figure 3: Table of likelihood scales in the National Risk Assessment 2012.

Qualitative scale (risk matrix)	Quantitative scale for likelihood assessment		
	Lower span	Magnitude	Upper span
Very high	≥0,2 on an annualised basis (≥ once per 5 years)	1 on an annualised basis (once per year)	1 (once per year)
High	≥0,02 on an annualised basis (≥once in 50 years)	0,1 on an annualised basis (once in 10 year)	<0,2 on an annualised basis (<once per 5 year)
Medium	≥0,002 on an annualised basis (≥once in 500 years)	0,0001 on an annualised basis (once in 1000 year)	<0,02 on an annualised basis (<once in 50 year)
Low	≥0,0002 on an annualised basis (≥once in 5000 year)	0,0001 on an annualised basis (once in 1000 year)	<0,002 on an annualised basis (<once in 500 year)
Very low	≥0	0,0001 on an annualised basis (once in 10 000 year)	<0,0002 on an annualised basis (<once in på 5 000 year)




The impacts of each analysed scenario have been assessed in the three categories: human impact, economic/environmental impact and political/social impact.²⁰ In the risk matrix, impact assessments are only presented for the category where the most significant impacts are realised. In other words, it is sufficient for the impacts for one category to be considered *very significant* for the scenario's overall impacts to also be assessed as *very significant*. There is no ranking between the impact categories. All the categories are considered equally important.

Figure 4: Table of impact scales in accordance with the EU Commission's guidelines.

Scales for impact assessment			
Scale in the risk matrix	Scales for each impact category		
	Quantitative scale, Human impact	Quantitative scale, Economic/Environmental impact	Qualitative scale Political/ Social impact
Very significant	≥ 50 dead and/or >100 severely injured	>SEK 1 billion	Very serious
Significant	10–49 dead and/or 50–100 severely injured	SEK 500 million–SEK 1 billion	Serious
Average	2–9 dead and/or 10–49 severely injured	SEK 100–499 million	Serious
Minor	1 dead and/or 1–9 severely injured	SEK 20–99 million	Minor
Minimal	No deaths or serious injuries, a number of minor injuries	<SEK 20 million	Minimal

The uncertainty reflects the reliability of the supporting data on which the previous assessments are built, i.e. it is an estimate of the level of confidence in the accuracy of the likelihood and impact assessments. For each event, the uncertainty has been assessed according to a scale whose three levels in the matrix are illustrated with black (*high*), grey (*medium*) and white (*low*), see Figure 5.

Figure 5: Table of uncertainty scale in the National Risk Assessment 2012.

Figure in the risk matrix	Designation, uncertainty	Explanation, justification for the assessment
	High	There are very few statistics and little data on which to base an assessment and the margin for error is significant.
	Medium	Some statistics and data are available. Experts consider the assessment to be the most reasonable, but there is a margin for error.
	Low	The assessment is supported by solid experience, statistics and other data. The assessment is possibly inaccurate, but it is not likely.

20. Described in the report by Winehav, M., Nevhage, B., Stenström, M., Veibäck, E. & Larsson, P. (2012). *Draft of methodology for national risk assessment – Results of method development 2011–2012*. Swedish Defence Research Agency (FOI), Stockholm.

The events' different combinations of likelihood and impact, together with the uncertainty assessments, represent different levels of risk. Events that are placed high up in the top-right corner of the matrix represent a higher risk level than the events placed in the bottom-left corner, provided the uncertainty assessment for the events' likelihood and impact assessments is equal. Events with a *high* level of uncertainty can, thus, be either more severe or less severe than indicated. It is important to note that if two events at the same location in the risk matrix differ with respect to the estimated uncertainty, the overall level of risk is then assessed as higher for the event with the highest uncertainty assessment.²¹

2.1.4 Comparing the events with regard to likelihood

Prolonged heat wave and school shooting are both assessed to have *high* likelihood and can, therefore, be considered to be the most probable of the events in the 2012 selection. The likelihood assessment for a prolonged heat wave in Sweden is primarily based on an increase in the occurrence of heat waves in Sweden due to climate change. The last 20 years (1991–2010) also show a greater number of hot summers with heat waves in Sweden, compared to the previous 30 years (1960–1990). The assessment of the likelihood that a school shooting, similar to the one described in the scenario, could occur in any school in Sweden is based on the fact that there has been an event involving deadly violence in Sweden (at a school dance in 1961, where one person died) and two school shootings in Finland. Threats of school shootings have also been reported in Sweden. In 2004, a 16-year-old student in Malmö was stopped before he had the chance to follow through with a planned massacre of his classmates. In 2010, a 33-year-old man threatened to carry out a school massacre at the Royal Institute of Technology (KTH) in Stockholm. There are also several examples of school shootings in Europe, the USA and across the world. The likelihood assessment is also based on the fact that it only requires minimal resources to carry out a school shooting, that the weapons of the type used in school shootings in other countries are relatively easy to acquire in Sweden, and that offenders today can inspire and copy each other via the internet.

Extensive disruption to GNSS and disruption to the drinking water supply due to diesel in Stockholm's raw water are assessed to have *very low* likelihood and are, thereby, considered to be the most improbable events. At a systemic level, GNSS is considered robust, but local disruptions are relatively common. The drinking water supply in Stockholm County is also robust. For both systems, several protective barriers would have to fail in order for either event to occur. The likelihood of these two events is, therefore, assessed to be very low.

2.1.5 Comparing the events with regard to impacts

The scenarios which have been assessed to result in the most significant impacts are *major fire on a cruise ship*, *fuel shortage leading to disruption in the food supply* and *failure of a large dam on a river*. All three scenarios are considered to lead to *very significant* impacts, but for different impact categories (human, economy/environmental and political/social). The scenarios *Fuel shortage leading to disruption in the food supply* and *failure of a large dam on a river* result in *very significant* impacts for the economy/environment, while *major fire on a cruise ship* results in *very significant* impacts for both economy/environment and the human category. The dam failure scenario may also lead to *very significant* human impacts, but the assessment is uncertain and dependent, to a great extent, on how the incident is managed. *Prolonged heat wave* is expected to

21. i.e. the risk level cannot be inferred from the event's position in the matrix, which is only a function of the likelihood and impact assessment. In order to determine the level of risk, the colour-highlighted uncertainty assessment should always be considered. The size of the circle that represents the event, however, is not significant.

result in *significant* impacts in the categories human and economy/environment, as the scenario will lead to the suffering of many people within risk groups and also result in comprehensive indirect effects (fires, power outages etc.).

The scenario *extensive disruption to GNSS* is predicted to result in *average* impacts for the economy/environment due to the decline in efficiency as a consequence of the scenario. *School shooting* is assessed to have *average* impacts for all impact categories (human, economy/environment and political/social). For this scenario, the political/social aspect is particularly important to emphasise.

The scenario *disruption to the drinking water supply due to diesel in Stockholm's raw water* is, from the point of view of impact, the least serious. The impacts for this scenario are assessed to be minor, particularly with regard to the political/social category.

2.1.6 Comparing the events with regard to uncertainty

The assessments for *disruption to GNSS* and *prolonged heat wave* are associated with *high* uncertainty. It is, therefore, possible that these assessments are under or overestimated. The analysis of *prolonged heat wave* showed the event to have significant variations in uncertainty. There is considerable data to be found within the health sector which indicates lower uncertainty. At the same time, the uncertainty is assessed to be *high* with regard to, for example, the heat wave's impact on electrical, IT and communications systems. It is, primarily, the uncertainty of the impact on these systems that results in the overall uncertainty in the scenario being assessed as *high*. The uncertainty level could be reduced to *medium*²² if a more thorough analysis were to be performed.

School shooting, fuel shortage leading to disruption in the food supply, failure of a large dam on a river and major fire on a cruise ship are all associated with a mean value of uncertainty. The only event associated with *low* uncertainty in these assessments is *disruption to the drinking water supply due to diesel in Stockholm's raw water*.

2.1.7 The events' overall risk

The risk matrix provides an overview of the assessments of the various events' likelihood, impact and uncertainty. In accordance with these, one of the following three events should represent the single greatest risk: *fuel shortage leading to disruption in the food supply, failure of a large dam on a river and prolonged heat wave*. This is because they were all assessed to have *significant to very significant* impacts and *medium to high* uncertainty. However, there are major differences between the assessments of these events that in the matrix does not account for, as the scale is insufficiently detailed and must be refined.

The three events are also assessed to have *medium to high* uncertainty in the estimates, which means that over or underestimations of the actual situation may have been made. This particularly applies to *prolonged heat wave*, which is deemed to have *high* uncertainty. For the other two events, the uncertainty has been assessed as *medium*. The event *extensive disruption to GNSS*, which is not designated as one of the most risk-related, is also considered to have *high* uncertainty, meaning that the assessments of likelihood and impact for this event may also be under- and/or overestimated. In this case, the uncertainty, as with *prolonged heat wave*, is dependent on the existence of major gaps in knowledge. In-depth analyses can, therefore, constitute the basis for reassessments, which, consequently, could be associated with fewer uncertainties.

22. This means that the assessment is based on access to certain statistics and data. Experts consider that the assessment performed is the most reasonable, but that there is room for potential inaccuracy.

Disruption to the drinking water supply due to diesel in Stockholm's raw water is, of the seven analysed events, the event with the lowest risk according to the assessments. This is because the event is the one with the lowest likelihood and impact, and that these assessments have low uncertainty.

2.2 General process and methodology

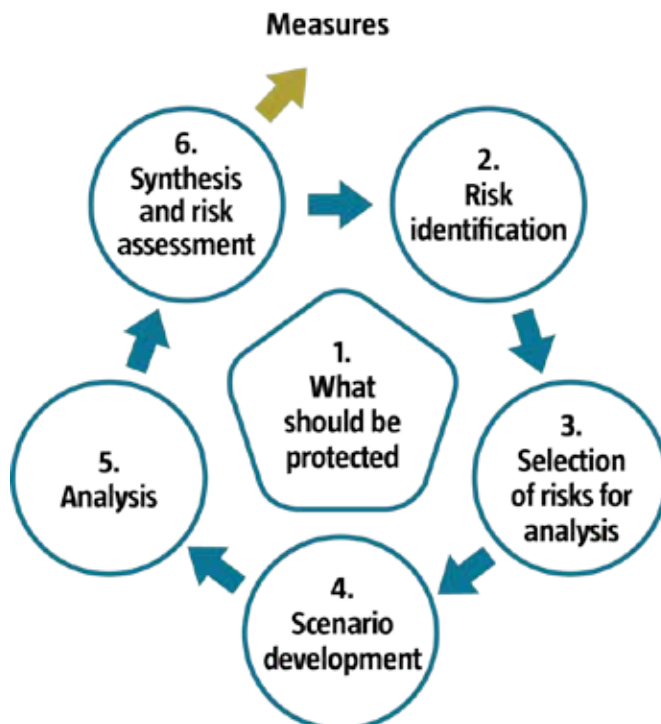
A valuable outcome of the National Risk Assessment 2012 is the work process and methodology that was developed and tested in the course of the year.

The work is intended to be conducted in six steps (see Figure 6):

- To specify what should be protected, i.e. to define the national protection values.
- Risk identification: identification of adverse events.
- Selection of events (risks) for analysis.
- Scenario development of the selected adverse events.
- Analysis of the scenarios: impact, likelihood and uncertainty assessments.
- Synthesis and evaluation of the risks.

In terms of content, the six steps are not entirely separate from one another. From risk identification (step 2) to the final synthesis and evaluation of risks (step 6), the national risk assessment consists of a series of analyses and assessments of the likelihood, impacts and uncertainty of different events with gradually increasing degrees of detail.

Figure 6: The six steps of the national risk assessment



2.2.1 What should be protected? – The national protection values

Human life and health covers Swedish citizens, those who live in Sweden, or are here temporarily and Swedes residing abroad. The protection value includes the physical and psychological health of those affected directly or indirectly (e.g. loved ones) by an event. It also covers people included in the EU's solidarity clause and those included in Sweden's international disaster relief.

Society's functionality covers the functionality and continuity of that which strongly impacts the daily lives of individuals, companies and other organisations (natural and legal persons). This also includes the expertise of staff in maintaining the functionality of society.

Democracy, rule of law and human rights and freedoms covers people's faith in democracy and the rule of law, as well as their confidence in society's institutions and political decision-making processes, leadership ability at different levels and lack of corruption and rights abuses.

Economic assets and the environment encompasses economic assets, in the form of private and public property, and the value of production of goods and services. It includes environment described as land, water and natural environment, biodiversity, valuable natural and cultural environments (environments in nature created and affected by people), and other cultural heritage in the form of personal property.

National sovereignty covers control over the nation's territory. This protection value applies primarily if the cause of the event is antagonistic.

2.2.2 Risk identification

Risk identification is the identification of events that may in some way threaten or cause negative impacts with regard to the protection values. The events are combinations of a protection value, a threat and a path of contact, and they are depicted without context or an assessment of their likelihood, impact or uncertainty. At this stage, the events are, therefore, not referred to as risks, but as "general events".

In order to select events as the basis for the later development of scenarios, MSB developed and catalogued more than 200 different events from risk and vulnerability analyses by public agencies from the years 2010 and 2011. On the basis of this material, a workshop was held with some 50 representatives from key governmental agencies and county administrative boards.²³ In this workshop, a review of the event catalogue was performed in order to, where possible, supplement it with other events and analyse the ways in which the protection values could be threatened. Participants also had the opportunity to submit their views on events which they felt it would be interesting to analyse in greater depth. A total of 113 proposals were submitted, several of which employed different ways of expressing the same point. Approximately 40 of these were assessed to be unique events. Following the workshop, the event catalogue was processed and improved, based on proposals from the workshop participants.

2.2.3 Selection of events for analysis

It was neither possible, nor necessary to conduct a deeper analysis of all 40 events remaining in the event catalogue. Based on current conditions in Sweden, MSB considers that a reasonable level of ambition is to analyse 5–10 events per year.

23. The workshop took place on 25 April 2012.

The 40 events were assessed based on the following criteria:

- Can the event be deemed to meet the criteria of a crisis in society?
- Can the impacts of the event be considered to constitute a national event?

The events were also selected based on their severity, i.e. the combination of how probable they are, how significant the impacts will be, should the event occur, and the uncertainty of the risk assessments. In other words, this step includes a rough likelihood, impact and uncertainty assessment of the events.

Based on the above criteria, 27 events were chosen for more in-depth analysis. All 27 events were judged to have met the criteria for a national event (as well as for a crisis in society, see Section 1.1.4, Key concepts).

- Pandemic
- Nuclear accident
- Disruption to transportation
- Disruption to electronic communications
- Disruption in electricity supply
- Disruption in the fuel supply
- Theft of/false information
- Dam failure
- Ice storm
- Social unrest with violent element
- School shooting
- Act of terrorism
- Contaminated drinking water supply (chemical spill)
- Contaminated drinking water supply (biological contamination)
- Solar storm
- Heat wave
- Storm
- Sulphur mist
- Epizootic
- Fire in protected objects
- Ship collision
- Flooding of watercourses
- Landslide
- Disruptions in the food supply
- Chemical dispersal via a bomb
- Space debris
- (Armed aggression)

Armed aggression was considered a too broad and insufficiently defined a phenomenon and was, therefore, excluded immediately. For the other 26 events, likelihood, impact and uncertainty assessments were once more conducted, this time based on a literature review. General events with *significant* and *very significant* impacts were carried forward in this step, which included all events. Thus, no events were excluded following these assessments. In order to reduce the number of events, an investigation was conducted to see if it was possible to combine some of the remaining events. This investigation resulted in seven new merged events:

- Disruption in the fuel supply/Disruption in the food supply
- Disruption to electricity supply/dam failure/flooding of inland waters
- Contaminated drinking water supply (chemical spill)/ship collision
- Disruption to electronic communications/space debris
- Pandemic/epizootic
- Act of terrorism/chemical dispersal via a bomb
- Disruption to electronic communications/solar storm

In addition, five additional events were rejected from the 2012 assessment, mainly for the following reasons:

- *Contaminated drinking water supply due to biological contamination*, as the event *contaminated drinking water supply* is included for other reasons.
- *Sulphur mist*, due to its relatively very low likelihood.
- *Landslide*, due to a combination of low likelihood and the event not being assessed as having *very significant* impacts.
- *Ice storm*, due to the relatively low likelihood of one occurring in Sweden.
- *Theft of false information*, due to it being considered a threat more than a general event.

Note that these events may be analysed in future risk assessments.

The 13 events that remained were investigated in relation to the national protection values to ensure that, when combined, they would impact several protection values. It was clear that each event threatens at least one protection value and that the events, taken together, threaten all protection values. Of the 13 events, *disruption to electronic communications/solar storm* and *storm* were removed as a basis for the scenario development in 2012 in order to limit the number of scenarios according to plan. These events, however, need to be developed into scenarios for analysis in the coming years. At this stage, considerations were also given to combining the events *school shooting* and *spread of social unrest and riots in Sweden*. However, the relationship between the events was considered too tenuous. As a result, 11 scenarios were finally developed:

- Extensive disruption to GNSS
- School shooting
- Disruption to the drinking water supply due to diesel discharge in Stockholm's raw water
- Fuel shortage leading to disruption in the food supply
- Prolonged heat wave
- Major fire on a cruise ship
- Failure of a large dam on a river
- Pandemic caused by influenza virus A/H5N1 (avian influenza virus)
- Nuclear disaster with radioactive discharge
- Terrorist attack in Stockholm – bombs at Sergels torg and T-centralen (Central Station)
- Spread of social unrest and riots in Sweden.

2.2.4 Scenario development

Using the events as a starting point, scenarios are then developed for further analysis with the relevant stakeholders. In order for the scenarios to be comparable and useful for risk assessment at the national level, they need to be structured in a similar way.

For this purpose, MSB has identified and employed a number of context-forming variables (see Appendix 2). It is important that the scenarios and the course of events therein are credible, not least for those who will participate in the analysis. This means that, scenarios ought to be developed according to the principle of *worst probable scenarios*, i.e. that the likelihood of the scenario occurring should not be non-existent and that it should be able to result in significant or very significant impacts. It also means that the values of scenario variables and other assumptions that may be specific to the scenario need to be checked against available data (e.g. what wind conditions have prevailed in recent years at the location chosen for a scenario in which the wind may have a significant effect on the impacts). Therefore, expert support is considered crucial during scenario development.

2.2.5 Analysis

In step 5, analysis, the scenarios that have been developed are analysed and evaluated in terms of their likelihood, impacts (direct and indirect) and uncertainty. It is essential that experts are involved in these assessments, in order to ensure quality.

The impact assessments are performed with the help of a guide to impact assessments. The impacts from the scenarios are evaluated and described on the basis of the five national protection values. Each protection value is then assessed based on one or more indicators.

Figure 6: Indicators for the national protection values

Protection values	Indicators
Society's functionality	1.1 Disruptions to everyday life
Human life and health	2.1 Number of fatalities
	2.2 Number of severely injured/ill
	2.3 Lack of fulfilment of basic needs
	2.4 Number of people who need to be evacuated
Economic values and the environment	3.1 Total economic impacts
	3.2 Impacts for nature and environment
Democracy, rule of law and human rights and freedoms	4.1 Social unrest resulting in negative behavioural changes
	4.2 Lack of confidence in public institutions
	4.3 Serious impact on national political decisions
	4.4 Lack of control over public institutions
	4.5 Impact on Sweden's reputation internationally
National sovereignty	5.1 Lack of control over territory

A likelihood assessment is then conducted for each scenario. The assessment mainly concerns the primary cause of the event and the direct impacts that are described in the scenario.

However, the events that are analysed are often such that the availability of relevant statistics and experiences is limited. It is, therefore, important to describe how the assessment is conducted and what it is based on. This is expressed in the uncertainty assessment.

With the help of the guide, the uncertainty in the assessments of impacts and likelihood is then finally evaluated and described (see Section 2.1.3 for a description of the scales for likelihood, impact and uncertainty assessments).

2.2.6 Synthesis and risk evaluation

The purpose of this step is to draw conclusions from the results of the risk analyses conducted in Step 5.

The results of the individual analyses are compiled and presented in a common risk matrix. The matrix shows the scenarios' relative likelihood, impact and uncertainty, making it possible, in some respects, to draw comparisons between them.

Conclusions are then drawn from the results of the risk assessment of the analysed scenarios in order to, in the following step, focus on measures and the prioritisation of resources and activities from a national perspective.

2.2.7 Proposed measures

As a final step, the idea is to identify, evaluate, prioritise and propose measures based on the analysis of the risk evaluation. These proposals will be checked against other central MSB assignments in the area of civil protection and emergency preparedness.

2.2.8 Working method 2012 – lessons and important revisions

The national risk assessment is, distinctively, a work in progress. As stated above, the risk assessment does not yet fully correspond to the European Commission's guidelines (2010). In order to fully evaluate the risks and to propose measures, additional methods and analyses are needed. Experiences from the assignment's first phase also indicate that a number of tested elements need to be revised or improved. This applies to key concepts and indicators for the assessments, the method for selecting events, as well as the development and analyses of scenarios.

The scale of the current risk matrix needs to be refined in order to illustrate differences between the three events that were judged to pose the greatest combined risks in the selection in 2012.

As shown above, the impact category *political/social impacts* in the European Commission's guidelines corresponds, at least partially, to two of the Swedish protection values, *society's functionality* and *democracy, rule of law and human rights and freedoms*. Society's functionality, however, has dimensions other than political and social; it is not yet clear how this protection value is to be considered in relation to the guidelines' impact categories. The protection value *democracy, rule of law and human rights and freedoms* is (as with the impact category *political/social impacts*) potentially very broad in scope. This protection value and its indicators may need to be further clarified. It is also possible that other indicators of relevance to the protection values should be considered.

The National Risk Assessment 2012 did not, through likelihood, impact and uncertainty assessment, succeed in distinguishing fewer than 24 more serious general events.²⁴ In order to obtain a manageable number of scenarios for analysis, 15 events were merged into 7 new events.

This procedure led to a number of complex scenarios. However, merging events is not an equivalent alternative to developing and analysing scenarios for each of the events. If an event that was previously independent becomes either the cause or the effect of other events, the composite event then constitutes a limiting factor in the analysis. The last event in a chain will become the main event in terms of impacts

24. i.e. of the 27 general events mentioned above (3.2.4 Selection of events for analysis) only sulphur mist, landslide, and ice storm were excluded, primarily due to an assessment of their likelihood and/or impact.

(e.g. disruption in the fuel supply leading to disruption to transportation leading to disruption in the food supply). All the events that together form a composite event may have causes and impacts other than those presupposed in the scenario. It is, therefore, essential to find an effective way of singling out a smaller number of events through assessments of likelihood, impact and uncertainty in relation to the criteria for a national event at the stage of risk selection. This also means that the criteria for a national event may need to be refined and supplemented.

From the composite events *contaminated drinking water supply (chemical spill)* and *ship collision*, the scenario *disruption to the drinking water supply due to diesel in Stockholm's raw water* was developed. Prior to analysis, this scenario was assessed to be of the type "worst probable". This was later revealed to be inaccurate given the Stockholm Region's advanced water treatment technology. An analysis at the stage of scenario development may apparently be flawed and in need of revision after a more detailed analysis has been carried out. In order to, as far as possible, prevent similar situations in future work, it is vital to ensure that scenario drafts are reviewed by experts with the relevant expertise.

The national risk assessment's six scenario analyses, in the form of workshops with experts and other key individuals, have been very rewarding in many respects. At the same time, these events have had several limitations and should be considered as only one element of the analysis. With one exception, the workshops took place over the course of a single day. Each workshop requires thorough preparatory and supplementary work. MSB cannot guarantee the participation of all relevant parties, which is why some stakeholders' views must be obtained in other ways. Variables, variable values and other assumptions behind a scenario need to be factually substantiated prior to a workshop. During the workshop, additional issues of relevance to the assessments of impacts, likelihood and uncertainty are usually identified. If these issues cannot be resolved on this occasion, they then need to be investigated further. In the scenario analyses of 2012, MSB did not have the time to further research the issues raised in the workshops to the extent desired. It is necessary to take this lesson into account when determining the number of future workshops, and to allocate more time for the supplementary research.

In the six workshops in 2012, the participants, under MSB's guidance, assessed the impacts of one scenario in groups. The participants subsequently evaluated three of these workshops by completing a survey. However, the survey did not specifically request how individual participants perceived the joint impact assessments and the conditions for conducting such assessments. Information of this kind is relevant, for example, for the uncertainty assessments. MSB will, therefore, revise the evaluation survey and routinely allow participants to evaluate all upcoming workshops related to scenario analyses in the national risk assessment.

2.3 The participants' views on the scenario analyses

For six of the seven scenarios analysed in 2012, the analysis was based largely on a workshop with experts and other key individuals. The participants were given the opportunity to evaluate three of these workshops, (*extensive disruption to GNSS, school shooting, fuel shortage leading to disruption in the food supply*), anonymously and individually, through a survey with both predefined and open responses. Of the 43 participants, 34 (79%) completed the survey.

Thirty two participants (94%) stated that the workshop had accomplished its purpose to a satisfactory or highly satisfactory degree, while the remaining two (6%) rated

its success as less than satisfactory.²⁵ Thirty three participants (97%) indicated that MSB had prepared their participation in the workshop in a satisfactory or highly satisfactory way, and one participant stated that MSB prepared their participation in a less than satisfactory way.

Twenty four participants (70%) stated that other individuals or organisations, who were not present, could have contributed to a making the workshop more successful. Five participants (15%) said that this was not the case and the same number said they did not know if other persons/organisations, not present, could have contributed to making the workshop more successful. Thirteen participants (38%) indicated that MSB should consider other ways to gather knowledge for the national risk assessment than through this kind of workshop. Twelve participants (35%) indicated that MSB should not do this and the other nine said they did not know.

Participants in the workshops on disruptions to GNSS and the food supply requested, to a particularly high degree, the involvement of other stakeholders. This is also apparent in the open responses. Participants in the workshop on disruption to the food supply intimated, among other things, that county administrative boards and representatives of various private organisations (trucking companies, wholesale trade, everyday commodity trade) should have been involved. Participants in the workshop on disruption to GNSS intimated that the financial sector, aviation (including private companies), SVT (The Swedish public service television company) and special experts on GNSS were missing. This circumstance can be assumed to be associated with uncertainty regarding the impact assessments, which was also expressed in some participants' open responses. Participants believed that stakeholders who were not present could have contributed to a somewhat different picture of the situation and provided information relevant to the impact assessment.

It was also evident in the open responses that the participants regarded the analysis workshops as very instructive, in part because they gained insight into other emergency management stakeholders' perceptions and a deeper understanding of the complexity of crises. Furthermore, they appreciated the coming together of agencies and professional groups at various levels and the opportunity to develop new networks. Some participants also felt that the scenario they analysed could be used as the basis for exercises within their own organisation and that the working method was an inspiration for their own risk and vulnerability analyses. In this way, several positive expectations regarding the national risk assessment conveyed by those involved in emergency management to MSB in 2011 were confirmed.²⁶

Overall, the evaluations provide MSB with valuable information about elements that, from a participant perspective, are particularly important to consider in future work with analyses in workshop form. They also show clearly that this approach to national risk assessment, from a civil contingencies standpoint, has substantial value beyond the goal of assessing as accurately and precisely as possible the degree of likelihood, impacts and uncertainty of various events.

25. The three workshops had the following objectives: (1) *To chart society's dependency on GNSS as well as describe and, to the extent possible, estimate the impacts of GNSS being rendered unavailable,* (2) *To describe and, to the extent possible, estimate the impacts of a school shooting in a Swedish school,* (3) *To describe and, to the extent possible, estimate the impacts of transportation disruptions in the food sector due to fuel shortage.*

26. MSB held a series of workshops for emergency management stakeholders in 2011 relating to the national risk identification that year. On these occasions, the benefits of the upcoming national risk assessment were discussed, among other relevant topics. Several governmental agency representatives suggested that the national risk assessment could contribute to greater consensus across subject and sector boundaries, as well as increased motivation in emergency management work and the organisations' own risk and vulnerability analyses.

3. Scenario analyses 2012

3. Scenario analyses 2012

This chapter is a summary of the scenario analyses conducted in 2012.²⁷ The scales for the likelihood, impact and uncertainty assessments below are explained in Section 2.1.3 (*Risk matrix for the National Risk Assessment 2012*).

3.1 Scenario – Extensive disruption to GNSS

It is late afternoon on a normal working day in November and many people are on their way home from work. In large parts of the country it is warm for the time of year, about 5 degrees, with heavy fog. Without warning, Sweden's access to GNSS-based services is suddenly shut down. The most obvious and immediate impacts are that positioning services will no longer give the correct position. These services are integrated into many systems and applications with widespread daily use, such as the map function in smartphones, car GPS devices and digital nautical charts.

In order to locate and navigate correctly, people must now use traditional methods such as maps (digital maps and nautical maps function as normal, but without correctly indicating position). Control centres with updates on the position of mobile units on a map lose this information. Emergency services control centres cannot see where emergency vehicles are located and similar information on buses and commuter trains also disappears. Shipping companies, airports and logistics companies are further examples of operations that cannot receive updated positioning information from monitored units using GNSS. However, several of these operations have other systems for navigation. Airports and air traffic control only use GNSS as a complement to systems that are certified and tested specifically for air traffic.

Less obvious impacts of unavailable GNSS occur in computer networks, guidance and monitoring systems, and communications systems that rely on obtaining information on the correct time and frequency via GNSS. The problems that arise can vary depending on the type of system redundancy in place. For example, systems can retrieve time and frequency information from a GNSS-independent source, have their own system clock, be GNSS-dependent with respect to system structure or application structure and have IT systems for back-up. GNSS is unavailable for two weeks. Many impacts are immediate but new problems can arise after the fact.

3.1.1 Thematic background

GNSS (Global Navigation Satellite System) is a collective term for satellite-based navigation systems such as GPS (USA), GLONASS (Russia), Galileo (EU/ESA) and Beidou/Compass (China). GNSS is widely used by many sectors in society. The services are mainly based on either positioning data (e.g. mapping, navigation support and device monitoring) or time data (e.g. synchronisation of time and frequency between different IT systems and UTC time²⁸).

GNSS use has increased in recent years, but the actual vulnerability of society to major disruptions in the systems is unclear. This was one of the reasons why MSB chose to develop a scenario involving GNSS for the general event *disruption to electronic communications*. To obtain a clearer picture of the situation also requires deeper analysis within individual sectors.

27. Complete analyses of all scenarios are found in the report, *Basis for National Risk Assessment 2012 – results from the Swedish national risk assessment*, Swedish Defence Research Agency (FOI-R-3612-SE), December 2012.

28. UTC, Coordinated Universal Time. UTC is the reference for accurate time indication the world over.

In Sweden, the most used kind of GNSS by far is the American GPS (Global Positioning System). Deliberate disruption of GPS receivers in select areas can be achieved using equipment that is relatively accessible. Persons or organisations with questionable intentions may acquire (illegal in Sweden) signal jammers by searching for components and manuals on the internet. These types of disruptions achieve local effects, up to a distance of 30 or 40 kilometres, depending on how the transmitter is mounted. Several countries, including Russia, China and some EU Member States, create redundancy by developing their own systems to complement and reduce dependence on GPS. In Sweden, GPS receivers have been intentionally disrupted and extensive disruption to GNSS has previously occurred in several parts of the world.²⁹ However, a GNSS signal has not, thus far, been rendered inactive in an entire country.

3.1.2 Impact assessment

The analysis is based largely on an expert workshop held on 11–12 September 2012 with representatives from the Swedish Coast Guard, the Swedish Maritime Administration, the Technical Research Institute of Sweden (SP), the Swedish National Space Board, Lantmäteriet: the Swedish Mapping, Cadastral and Land Registration Authority, the Swedish Post and Telecom Authority (PTS), the National Police Board (RPS), the Swedish Transport Agency, SOS Alarm, the Swedish Association of Road Transport Companies, Malung-Sälen Municipality, the Swedish Armed Forces, MSB and the Swedish Defence Research Agency (FOI). Prior to this, a broad survey was conducted of how GNSS is used in Sweden. The workshop participants were also given the opportunity to comment on the processed results.

A sudden interruption in the availability of GNSS-based services could have significant economic impacts. In rare cases, a disruption could have impacts for human life and health. There is currently no complete picture of all the operations that use and depend on GNSS for time synchronisation and time-stamping. The analysis in the national risk assessment shows that many sectors may be dependent on GNSS services and that a disruption would have serious consequences for society.

GNSS dependency in vital societal functions needs to be investigated more closely. Electronic communications and electricity supply appear to be important sectors for further examination. A more comprehensive survey and in-depth analysis could increase awareness of the level of dependence in systems and society. Once dependence is established, the work to secure redundancy measures can continue. Overall, the impacts of inaccessible GNSS services are assessed to be *average*.

3.1.3 Assessment of likelihood

The GNSS system GPS is, at a systemic level, considered robust. If the number of operational satellites decreases, positioning accuracy deteriorates in areas with poor coverage, while frequency synchronisation does not require the same number of satellites in operation.

It is possible to disrupt all radio-based systems. However, the likelihood of GNSS being rendered unavailable in the entire country is considered by MSB to be *very low*.

29. Extensive GNSS disruptions have occurred during the second Iraq war (2003–2011), during the military testing of radar systems in San Diego (2007), at the airport in Newark (2009) and in suspected North Korean operations against South Korea in 2012.

3.1.4 Uncertainty assessment

Uncertainty regarding the impacts within certain key sectors is high, meaning that the entire impact assessment must be regarded as uncertain. Extensive power outages and disruptions in electronic communication overshadow other possible impacts of inaccessible GNSS. Uncertainty in the assessments of impacts for these specific functions is particularly high, as access to statistics and data is extremely limited and there are no actual events or full-scale attempts from which to seek guidance.

The GPS system is so robust and has so many satellites in orbit that the likelihood of a major disruption is extremely low. The uncertainty in this assessment is low.³⁰ Overall, the uncertainty for this scenario is assessed as *high*.³¹

3.2 Scenario – school shooting

One weekday morning at an upper-secondary school in a municipality with about 30,000 residents, an 18-year-old student unexpectedly starts shooting at students and staff. The shooting goes on for 7–8 minutes before the first police patrol arrives. The perpetrator barricades himself inside the school building and continues to shoot, now also at other people in the vicinity. The police are, therefore, forced to retreat. Barriers are established and those fleeing from the school are taken safely into custody. A task force searches the school building and finds the perpetrator in a classroom after an hour and a half. He is unconscious, having attempted to commit suicide by shooting himself in the head.

Outside the barriers are groups of confused and crying pupils. They are taken care of by the police, medical and school personnel, and relatives who have rushed to the scene after being informed of the incident.

The pressure from the media and the public to learn more about the event is intense. In social media, there is a widespread exchange of both accurate information and rumours. The school shooting claimed the lives of seven victims – one teacher and six pupils. In addition, two pupils received minor gunshot wounds and five other students and a teacher have received minor injuries during the escape from the school. The perpetrator later died as a result of the gunshot wound.

3.2.1 Thematic background

So-called school shootings are an extreme form of violence in school environments in which pupils and/or staff are subjected to violence inflicted using firearms. The incident that took place in Newton, Connecticut, USA, on 15 December 2012 claimed the lives of 28 victims. The school shooting in Bath, Michigan, USA, (1927) involving 45 fatalities is one of history's most extreme instances of this kind, while 15 people lost their lives in the highly documented Columbine massacre outside Denver in 1999. Finland has, in recent times, experienced two school shootings, in Tusby (Jokela High School in 2007) and Kauhajoki (local division of Seinäjoki University of Applied Sciences in 2008), where 8 and 11 people respectively were killed. In 1961 there was a school shooting in Sweden in Kungälv School with one fatality and six injured. In Malmö in 2004, a 16 year old pupil was prevented from carrying out a planned massacre, and several cases of threats of violence against schools have occurred in Eskilstuna, Örebro and Piteå, to name a few.

30. With regard to deliberate disruptions, however, the uncertainty is high. It is difficult to anticipate the agenda of antagonists and these can change rapidly.

31. This means that there are very few statistics and little data as support, and the likelihood of error is high. An assessment would more or less be considered pure guess work.

The technical police term for school shootings is 'ongoing lethal violence in a school'. In the national risk assessment, the scenario is nevertheless called a school shooting since ongoing lethal violence is a broader term that can also refer to violence exercised in other ways than solely with firearms.

3.2.2 Impact assessment

The analysis is based largely on an expert workshop held on 25 September 2012 with representatives from the Ministry of Education and Research, the Swedish National Agency for Education, the National Board of Health and Welfare, the County Administrative Board of Skåne, the police authorities in Skåne and Stockholm County, the County Council/Region Skåne (Emergency Medicine), two municipalities (emergency services, crisis management and crisis support functions as well as school principals), Malmö University and crisis communicators from MSB. The scenario had previously been agreed upon with representatives from the police, a county administrative board and a municipality. The workshop participants were also given the opportunity to comment afterwards on the processed results.

A general conclusion is that the police, emergency services and the medical and social care services, would handle the incident with normal operational resources. None of these functions would be overloaded.

Disruptions can be expected primarily within the school system and the affected municipality. The pressure on the municipality would initially be enormous. Key stakeholder in the emergency preparedness system at the national level would require information about the ongoing situation as well as about what measures were taken. In the affected locality, the municipality is expected to take action through, for example, activating emergency support staff and central crisis management/the Crisis Management Committee. Media and the public would contact the municipality with questions and demands for municipal action. Municipal operations without direct relevance to accident management would be given lower priority.

The societal costs of a school shooting are difficult to assess. They can, however, amount to several million kronor over the span of few years. Based on experiences from the Finnish school shootings and the, so-called, discotheque fire in Gothenburg (1998), it is considered reasonable, taking into account the municipality's size, that, for at least a year, approximately 50 additional full-time positions would need to be created, especially for dealing with the psychologically traumatised.

The feeling of insecurity will also increase in the country's population in general. There would be extensive spreading of rumours, not least in social media. What this would lead to is difficult to predict and depends largely on how effectively society can respond to the rumours. The event could lead to increased demands on monitoring and control in schools, by way of security guards, cameras and metal detectors, which in turn would fundamentally change the school environment.

Overall, the scenario is assessed to have *average* impacts.

3.2.3 Assessment of likelihood

Until now, one school shooting has occurred in Sweden (1961) and, in several later cases, threats of massacres have been issued against schools. Events similar to the scenario have also occurred in the United States and Finland. It only requires minimal resources to carry out a school shooting and the weapons of the type used in school shootings in other countries are relatively easy to acquire in Sweden. Offenders today can even inspire and copy each other via the internet. It is realistic to believe that such an event could occur in a Swedish school in the foreseeable future. Therefore,

the assessment is that the likelihood is about 0.1 on an annualised basis, which corresponds to the order of magnitude of once in ten years. This corresponds to a high level of likelihood in the national risk assessment.

3.2.4 Uncertainty assessment

Uncertainty in the impact assessment is judged to be *medium*³². Particular uncertainty is attached to the assessments of how many people would be affected by mental illness in the short and long term, the magnitude of the related economic impacts, and the scope and effects of resulting rumours. In these cases, the uncertainty is assessed to be *high*.

Assessment of the likelihood of antagonistic acts is often associated with high uncertainty. The intentions and resources of the antagonist are crucial in determining whether or not an attack will occur. There are very few statistics available, but there are examples of actual events and incidents in both Sweden and the surrounding area. Uncertainty in the assessment of likelihood is, therefore, *medium*.

Overall, the uncertainty in the assessments of the scenario is judged to be *medium* according to the scale in the national risk assessment.

3.3 Scenario – fuel shortage leading to disruption in the food supply

On Sunday, 26 August, a nation in the Middle East threatens to close the Strait of Wine,³³ which is a narrow and very important passage for oil exports to the whole world.

Crude oil prices are controlled by the market which reacts strongly to the development. The effects are immediate. Before the week's end, the price has tripled.

Strikes and blockades break out across Europe. In Sweden, the petrol companies raise the price of fuel. By the end of the week, a litre of petrol costs SEK 45. The price of diesel has been raised to SEK 42 per litre.

Early Saturday morning on 1 September, transport companies set up a blockade of the oil refinery in Lysekil. On Sunday, the protests spread to Gothenburg after which all refineries in Sweden are blockaded and prevented from delivering fuel to the depots around the country.

On Monday morning, 3 September, a large proportion of all fuel deliveries are prevented due to the blockades.

This event has swift consequences for the whole of society. Fuel is stockpiled by those motorists and haulage contractors that are not participating in the protests. This results in 80 per cent of Sweden's petrol stations being completely or partially without fuel by the evening of 3 September.

On Monday 10 September, a week after the fuel shortage arose, the Government and the transport companies finally come to an agreement. The blockades are lifted and tankers begin transporting fuel from the depots to the country's various filling stations.

3.3.1 Thematic background

Sweden imports crude oil on the global oil production market, mainly from Denmark, Norway and Russia. Crude oil comes to the ports of Gothenburg and Lysekil and is

32. This means that the assessment is based on access to certain statistics and data. Experts consider that the assessment performed is the most reasonable, but that there is room for potential inaccuracy.

33. Fictitious strait.

stored in caverns, primarily at the refinery in Lysekil. The three refineries in Sweden that manufacture fuel and heating oils are also found at these locations.³⁴

In general, finished oil products are initially stored at oil depots. The products are then transported, mainly by tankers, to filling stations and end users such as property owners. On average, each filling station receives around two refills per week. However, the variation in this regard is significant. Some stations are filled several times a day, others, perhaps, only every other week. The increased use of diesel in private cars has led to a greater number of filling stations needing to be replenished more frequently.

In accordance with the requirements of the International Energy Agency (IEA), Sweden has a peacetime oil stockpile which covers 90 days of normal consumption. The idea is that it should be used in the case of a total interruption of deliveries to Sweden. The oil stockpile is divided between different depots in the country. As a rule, the trucking companies in Sweden have negligible or very small fuel reserves (enough for 24–48 hours).³⁵

3.3.2 Impact assessment

The analysis is based largely on an expert workshop held on 2 October 2012 with representatives from the Swedish Energy Agency, the Swedish Board of Agriculture, the National Food Agency, the Swedish Transport Administration, the technical consultant company Combitech, the Swedish Institute of Agricultural and Environmental Engineering (JTI), the Swedish Association of Road Transport Companies, crisis communicators from MSB and the Swedish Defence Research Agency (FOI). The scenario had previously been agreed upon with representatives from the Swedish Association of Road Transport Companies and the Swedish Defence Research Agency.³⁶ The workshop participants were also given the opportunity to comment on the processed results.

Many areas of society are dependent on functional transportation system. The scenario in question would immediately lead to significant strain. There would be disruption to all branches of the food supply chain, as well as for consumers.

When all the impacts of transport disruption in the food sector are combined, it becomes apparent that society would find it difficult to function. The scenario is, therefore, judged to have *very significant* impacts.

Society would recover when the deliveries start up again, but there may be large geographical differences. Certain specialist products could be affected for months by the disruption.

No person with good general health and a stable social situation is expected to starve to death as a direct result of this event. However, it is uncertain how more vulnerable groups would fare. People in hospitals, care facilities and institutions are highly dependent on having all their meals arranged for them. These groups, as well as people with weak or non-existent social networks, are expected to be hit harder than others. The cost to society is difficult to assess, but could amount to several billion SEK, primarily as a result of the decline in production.

34. Trygg energiförsörjning 2010.

35. Swedish Emergency Management Agency, *Dependence and impact analysis, transport*, 2008.

36. A similar scenario was developed and analysed in 2002 and 2005 by the then Emergency Management Agency in collaboration with the Swedish Energy Agency (Swedish Emergency Management Agency, *Omvärldsexempel*, 2005). The scenario constituted part of the supporting data in the development of the scenario for the national risk assessment, which was also inspired by actual fuel blockades in France and the United Kingdom in 2000.

3.3.3 Assessment of likelihood

The background associated with this scenario has occurred in real life, i.e. a nation in the Middle East has *threatened* to close a strait of key strategic and logistic importance for oil exports. That such a threat could become a reality is unlikely, however, as the closure would impact their own nation at least as hard as it would the rest of the world. In other words, it is far from certain that the market would take such a threat seriously. With regard to fuel blockades, this situation has arisen many times in Europe, e.g. in France and the United Kingdom in the autumn of 2000.

Sweden has neither past experience of extensive fuel blockades nor the tradition of such protests and blockades such as those organised by French farmers. In recent years, transport companies in Sweden have stated that they are under increasing pressure, mainly from taxes and regulations. Since joining the European Community, their costs have increased and profit margins have plummeted sharply. In order to offer competitive prices, more and more companies have chosen to try to lower costs by hiring foreign workers. This has contributed to increased competition and a “price war”, with profit margins being even harder hit as a result.

The scenario’s course of events is reminiscent of the events in France and the United Kingdom. A blockade of Swedish oil refineries and depots has never taken place, but could potentially follow a similar pattern. In the workshop, it was assessed that the scenario could happen and that the course of events is reasonable. MSB judges the event to have a *medium* likelihood.

3.3.4 Uncertainty assessment

The uncertainty of the impact assessment in this scenario has, overall, been assessed as *medium*. Particular uncertainty is attached to the assessments of how many people would die, become seriously injured or ill, the magnitude of the economic impacts and the scope and effects of the spread of rumours. In such cases, the uncertainty is assessed to be *high*.

The uncertainty in the assessment of likelihood is also judged to be *medium*. There is *low* uncertainty in the assessment of the event that, according to the scenario, triggers the sharp price increase and the blockade. In the workshop, however, the subsequent events were assessed as reasonable. The uncertainty in the assessment of likelihood is, therefore, judged to be *medium*.³⁷

Overall, the uncertainty in the assessment of the scenario is judged to be *medium* according to the scale in the national risk assessment.

3.4 Scenario – prolonged heat wave

The entire summer is unusually hot. As early as May, seasonally high daytime temperatures are recorded at multiple locations and it continues to be hot at times throughout June. Precipitation is unusually low. By mid-July, soil conditions are dry and the groundwater level is low. As the heat wave peaks in the first two weeks of August, maximum temperatures plateau at around 30–35 degrees and do not drop below 18 degrees at night. The highest temperature reaches 38 degrees, which occurs on two occasions, and the night-time temperature is, at most, just over 24 degrees. Many elderly people are already bothered by the heat in the first few days of the heat wave, and, for certain professional groups, the working conditions are trying. Water quality deteriorates significantly and samples indicate that the water is unfit for human consumption in several water-

37. Sharp price increases for diesel, a blockade that reduces the availability of fuel and the sequence of events in the scenario, could have causes other than the oil market reacting to the threat of closure of a strait of importance for oil exports.

courses. The dry land results in frequent minor vegetation fires along railways. Areas consisting mainly of grassland are affected, in particular.

The number of traffic accidents increases on particularly sunny stretches of road where the asphalt has softened and become slippery in the heat. Rail traffic also suffers recurring disruption as a result of factors such as heat distortion.³⁸ The number of deaths increases during the heat wave, especially among the mentally ill, the elderly and people with COPD. On livestock farms, an unusually large number of animals perish from heat-stroke, predominantly pigs and poultry. The heat also affects electrical wires and cables, causing power outages, particularly in local and regional networks with lower voltage levels. At the end of the heat wave, the region is hit by several thunderstorms. Several bolts of lightning lead to vegetation fires that spread rapidly across the arid landscape, particularly in the region's wooded areas. In many places, thunderstorms cause heavy localised precipitation, leading to minor floods in these areas. In mid-August, a cold front passes over the county from the north, and the high temperatures change to more normal summer temperatures.

3.4.1 Thematic background

In recent years, the risk of heat waves has attracted increased attention, partly as a result of several severe heat waves in Europe (e.g. France in 2003, Russia in 2010). Due to climate change, heat waves may also become increasingly common on more northern latitudes.³⁹ Sweden has experienced several heat waves, but none have been as extensive as that described in the scenario.

The heat wave in the Örebro area during the summer of 1994 lasted 13 days, with a maximum average daily temperature of 25.1°C. It resulted in dwindling groundwater and intense thunderstorms that caused forest fires, tornados, hailstorms and fallen trees. Rail and road traffic was badly affected, the water supply in Lindesberg was knocked out, and agricultural land and property was damaged. The heat wave in Skåne in the summer of 2006, which lasted more than one month, resulted in grass and forest fires and major crop losses due to drought.⁴⁰ Accident & emergency wards received more visitors, particularly the elderly suffering from the heat.

The scenario is notably different from most real heat waves because it is based on the exceptional temperature anomaly recorded in Paris during the continental European heat wave of 2003. However, it is limited to the region Örebro-Hallsberg, while a real heat wave would affect a larger geographic area.

3.4.2 Impact assessment

The analysis is partly based on a workshop held in cooperation with the County Administrative Board in Örebro County on 19 November 2012 involving representatives from the municipalities of Örebro and Hallsberg (safety and water), Nerikes Fire Brigade, the public transport authority for the counties of the Mälaren Valley, the police, the Swedish Transport Administration, Swedish State Railways, the freight transportation

38. A heat distortion is a bending or lateral movement of a railway track due to the sun's heat. www.trafikverket.se

39. SMHI (2012), Swedish Portal for Climate Change Adaptation, www.klimatanpassning.se/Hur-forandras-klimatet/Temperatur/varmebolja-1.21295 and MSB (2012) Impact of heat waves on society's safety, *A knowledge and research survey focusing on Sweden and impacts outside the health sector*, MSB 362, January 2012.

40. During the heat wave in Skåne in 2006, the average temperature for the month of July was 21.3°C and the maximum temperature was 31.4°C.

company Green Cargo, and the bus company Nobina.⁴¹ The scenario had previously been agreed upon with representatives from the Swedish Meteorological and Hydrological Institute (SMHI), the Swedish Transport Administration, the FOI and MSB.

A general conclusion is that a heat wave of this magnitude would have implications for a range of societal functions. Even if the disruptions are individually considered relatively modest, the cumulative effect can present an escalating course of events with serious impacts. The scenario would have consequences for society's functionality, including the disruption of rail and road traffic. In the case of the railway, temperature fluctuations can create heat distortions and affect signalling systems. Roads are affected by, so-called, 'bleeding asphalt', but also by fires and the combination of drought and heavy rain. Disruption to traffic on roads mainly occurs regionally and locally, while disruption to rail traffic affect a larger geographical area.

Experience shows us that deaths caused by heat are particularly common among the elderly, the mentally ill, those with dementia and those suffering from COPD or other pulmonary diseases. Infants are also among those who are vulnerable. The number of people in the Örebro-Hallsberg region who die as a result of the heat is expected to range from 30 to 100, based on previous models for estimating the health impact of heat waves with relatively high uncertainty.⁴² The number of people who sustain serious or very serious injuries as a result of, for example, heat-related fires, traffic accidents, food poisoning and health problems, is estimated to be in the range of 25 to 100.

The economic impact of a heat wave, according to this scenario, affects a wide range of assets such as infrastructure, buildings, technical equipment, livestock, and forestry and land. Financial losses result from, for example, the decline in production of food-stuffs and forestry. Indirect impacts, such as reduced capacity in and disruption to the electricity supply, IT systems, and freight and passenger traffic, also result in costs. In addition, costs are incurred for management and repairs. The economic impacts may be assumed to be significant, but the extent of the damage that arises was assessed in the workshop as far too vague to allow a cost estimate to be made.

A heat wave could lead to reduced confidence in the public institutions in Sweden. In this case, medical and social care services would be particularly vulnerable as, in the workshop, confidence in these organisations was considered to be relatively low, based on negative media coverage. Particularly with regard to elderly care, whose users represent a severely affected group, in terms of health, in this scenario.

The assessment that so many people would perish or sustain serious injury and that the scenario would result in widespread disruption, leads to the scenario being judged as having *significant* impacts.

3.4.3 Assessment of likelihood

An extensive heat wave is likely to occur in Sweden within the next five to ten years, although it may not necessarily involve the exact temperatures indicated in the scenario, or have been preceded by a dry spring.⁴³ The likelihood of this increases in tandem

41. This workshop was organised within the framework of the adjacent project "Impact of heat waves on society's safety" conducted by the FOI on behalf of MSB. The workshop's analytical focus was on the scenario's impact on vital societal functions, in particular transportation, protection and safety, and drinking water supply. The workshop, which was not primarily part of the national assessment assignment, was focused on the local and regional contexts.

42. Swedish National Institute of Public Health (2010), *Heat waves and mortality among vulnerable groups – a Swedish study*, R 2010:12

43. A heat wave can also result from a spring with high precipitation, with somewhat different impacts. For example, the likelihood of vegetation fires would in this case be less.

with climate change. Over the last 20 years (1991–2010), there have been a greater number of hot summers in Sweden than in the previous 30 years (1960–1990).⁴⁴ The likelihood is therefore assessed to be *high*.⁴⁵

3.4.4 Uncertainty assessment

Overall, the uncertainty of the impact assessment is judged to be *high*. The analysis of the scenario showed the event to have significant variations in uncertainty. There are considerable statistics relating to the area of health, which indicate a lower uncertainty assessment, while uncertainty is high in terms the effects of a heat wave on electrical, IT and communications systems, as well as the economic impacts.

The uncertainty of the likelihood assessment is *low*, although slightly higher with regard to the likelihood that the specific region of the scenario would be hit by a heat wave. In addition, the analysis lacked the participation of certain stakeholders that could have contributed to better estimates of impacts, costs and uncertainties.

Overall, this means that the scenario is assessed to be associated with *high* uncertainty.

3.5 Scenario – disruption to the drinking water supply due to diesel in Stockholm’s raw water

It is a weekday afternoon in February. The sky is grey, it is a few degrees below zero and the snow is falling heavily. A large vessel carrying diesel fuel crashes near the intake to Görväln waterworks on Skeftingeholmen in Järfälla. Large quantities of diesel leak out into the water. For some reason, the waterworks’ staff receive no information about the accident and contaminated raw water is pumped into the treatment process.

Diesel-contaminated water passes unnoticed through the waterworks and, after about three hours, is pumped into the water main that supplies more than half a million people in 13 municipalities. The water is not dangerous to human health, but smells and tastes of diesel. This means that it is unfit for drinking, but usable for toilet and other functions that do not require the water to be potable.

Initially, it is possible to meet drinking water needs by way of bottled water from shops, emergency water for prioritised cases and obtaining water from southern Stockholm County. There are many properties in the area considered especially sensitive to the loss of drinking water, for example, hospitals, prisons, retirement homes and livestock farms. Görväln waterworks uses permanent active carbon filters in the treatment process and can treat diesel-contaminated water with powdered carbon. Environmental clean-up is made difficult by the darkness, cold and ice of winter.

3.5.1 Thematic background

Drinking water is one of the most important factors which enable society to function. In addition to drinking water, households need water for cooking, toilets and showers. Hospitals are particularly sensitive to disruption to the water supply. Water is required for all food processing and to maintain hygienic food production. Water is also needed in industries, offices, municipal operations and for district heating and the emergency services.

44. SMHI (2011), *Heat waves in Sweden*, Fact sheet 49-2011.

45. The likelihood of the Örebro-Hallsberg region being hit by a heat wave is lower, but still considered high. Temperature data from SMHI shows that the county has experienced 16 heat waves in the last 50 years, four of which occurred during 2000–2010 alone. County Administrative Board in Örebro County (2011), *Heat waves in Örebro County. An analysis of past heat waves and measures that may need to be taken prior to future heat waves*, 2011:23.

The scenario analysed involves Lake Mälaren as a source of drinking water for 1.7 million people in the Stockholm area, where three companies (the Northern Water Board, the Stockholm Water Company and Telge Nät) together produce drinking water for the majority of the county's municipalities and an additional two municipalities. Three major waterworks (Görväln, Lovö and Norsborg) are responsible for approximately 90 per cent of the county's public water supply.

Incidents similar to the scenario have occurred in real life, for example, in 1986, when parts of Lake Mälaren were polluted by an oil spill in the shipping lane between the Beckholm Strait and Kanan. The spill, which was estimated at 250 litres, consisted of both heating oil and petrol and probably came from a freight vessel. The contamination was discovered by a private individual who contacted SOS Alarm after having detected a strong smell of oil in the lake water. Following this discovery, the raw water intake at Norsborg waterworks was reduced to minimum.⁴⁶

3.5.2 Impact assessment

The analysis is partly based on a workshop that the County Administrative Board of Stockholm arranged with the National Food Agency and MSB on 25 September 2012, involving representatives from 22 of the 26 municipalities, as well as the Association of Local Authorities in Stockholm County⁴⁷, the Swedish Coast Guard, the Northern Water Board, Roslagsvatten AB, the Stockholm Water Company, Stockholm County Council, Swedavia, Radio Sweden, Södertörn Fire Protection Association and Telge Nät AB. The processed results were discussed and agreed upon with the County Administrative Board of Stockholm, the Stockholm Water Company, the Northern Water Board and the municipalities of Vallentuna and Österåker in particular.⁴⁸

The quality and safety of the region's water supply is adequate, however, the fact that the county's public water supply is entirely dependent on eastern Lake Mälaren creates a significant vulnerability. The impacts on society depend on how high the concentrations of diesel in the drinking water would be. Once the drinking water smells of diesel, it is then considered unusable by the National Food Agency, even if it is not directly harmful to health.

The Northern Water Board, which, among other things, operates Görväln waterworks, supplies an area with a population of around 800,000. As the Stockholm area has several waterworks, the impacts of disruptions in one of these are limited, as the other plants can produce and deliver water, at least to some extent.

The assessment is that there are no fatalities as a result of the scenario. The likelihood of someone drinking the contaminated water by mistake is very low. The majority of the population within the water distribution area would not suffer from any illness. The need for emergency water supplies would arise in hospitals, care facilities and other institutions. Other vulnerable groups in society include people with dementia, the mentally ill, the disabled, children and the elderly.

46. Norsborg waterworks had previously been exposed to the discharge of other fuels, for example, in 1985 when a consumer detected an odour of petrol in their water from a discharge that could not be identified. Marcus Larsson, Separation of diesel oil with activated carbon for drinking water treatment, dissertation UPTEC (2008), page 5.

47. The following municipalities were represented: Danderyd, Ekerö, Haninge, Huddinge, Järfälla, the City of Lidingö, Norrtälje, Nykvarn, Nynäshamn, Salem, Sigtuna, Sollentuna, the City of Solna, the City of Stockholm, the City of Sundbyberg, Södertälje, Tyresö, Täby, Upplands-Bro, Upplands Väsby, Vallentuna and Österåker.

48. This scenario was further developed from the drinking water scenario for Stockholm County created by MSB for the special capability assessment in 2012, in close cooperation with the County Administrative Board of Stockholm, the Stockholm Water Company and the Northern Water Board. The development of the current scenario involved, among other things, study visits to Görväln waterworks.

That the water has become undrinkable constitutes a challenge in terms of information, where it is more obvious how information flows to the municipality than how it flows from the municipality to the citizens. There are several channels available and coordination between those responsible for disseminating information becomes crucial. It is important that contradictory information is not passed on to the general public.

In the case of agriculture and food production, the scenario would result in direct impacts. There is currently no information to be found on how many farmers and stable owners in the county have access to their own well.

The economic impacts of the scenario are judged to be limited. Lake Mälaren's value as a drinking water resource is, however, very high. During the workshop, drinking water production was valued at SEK 2 billion per year, and more protracted events than that of the scenario could have major economic impacts.

An event similar to the scenario could involve demands for a national effort to strengthen the region's or the country's drinking water supply.

Overall, the scenario is assessed to have *minor* impacts according to the scale in the national risk assessment.

3.5.3 Assessment of likelihood

The likelihood of this particular scenario occurring⁴⁹ depends on the likelihood of a number of determining subsidiary events:

- A merchant vessel carrying diesel springs a leak in close enough proximity to the raw water intake at Görväln waterworks. The plant's staff do not discover the incident or receive any information about the damage to the ship from the responsible authorities.
- Diesel-contaminated raw water enters unnoticed into the waterworks' treatment process.
- Diesel passes through the treatment process without detection and diesel-contaminated drinking water is released into the water main.

In the unlikely event that the staff at the Görväln waterworks remain unaware that a large ship had foundered nearby, it is, nonetheless, probable that the diesel would be detected directly on entering the waterworks due to its distinctive odour. In this event, powdered carbon would be added to eliminate the odour and taste.

If the diesel is not initially detected, but nonetheless enters the waterworks system, it is still very probable that it would be discovered within two hours, after which it is still possible to add powdered carbon before the contaminated water is released into the main.

In summary, the likelihood of the diesel-contaminated water passing into the water main due to a ship accident is judged to be 0.0001 on an annualised basis (once in 10,000 years), which corresponds to a *very low* likelihood.

3.5.4 Uncertainty assessment

Uncertainty in both the likelihood and impact assessment is judged as *low*. It is primarily the wealth of experience among the participants in the analysis and the experts from the water authorities in Stockholm County that speaks in favour of this assessment. The assessment may, nevertheless, be inaccurate, but this is unlikely.

49. In this scenario, the likelihood of this specific event happening is assessed, as opposed to a similar event.

3.6 Scenario –failure of a large dam on a river

The spring flood in southern Norrland and northern Svealand is unusually heavy this year, following a snowy winter. The country's central regions also receive substantial summer precipitation. Both natural reservoirs and storage reservoirs are well stocked for this time of year. On 31 August, SMHI issues the summer's first class 3 warning for high floods on parts of the Lillälven, Ljusnan and Voxnan. There are also large flooded areas along the Dalälven. A storm in the mountains of Jämtland results in unfavourable waves arising in a reservoir, the longitudinal axis of which is in the direction of the wind. Despite best efforts at discharge⁵⁰ using the spillways, the reservoir continues to rise and now reaches the dam's limit. Suddenly water starts to gush out in an area at the top of the dam's downstream slope. At 21:00, Vattenregleringsföretagen (the Water Regulation Association) alerts SOS Alarm to the dam failure and that water is rapidly making its way down to the nearest village. In accordance with the plan for the class A alert "Failure of dam X", SOS Alarm alerts the owner of the dam, emergency services, police, county councils, the Swedish Transport Administration, Svenska Kraftnät (Swedish National Grid), county administrative boards and Radio Sweden. An important announcement to the general public is broadcast on both radio and TV. In nearby downstream communities, low-lying areas in the vicinity of the river begin immediate evacuation. Within only one hour, the flood threatens to engulf homes and properties. It also threatens roads, bridges, railways, electrical lines and communications infrastructure. The flood gradually evens out and takes on the form of rapidly rising water levels further downstream in the river. When the flood waters reach downstream hydropower reservoirs and dams, these too are destroyed, further adding to the flooding and devastation along the river valley.

3.6.1 Thematic background

There are approximately 10,000 dams in Sweden. In about 200 of these facilities, a dam failure could have major impacts for life, health, environment or economic values, and, when some twenty dams are involved, the impacts of a failure would be very significant. The scenario describes a dam failure in one of the country's largest hydroelectric dams, high up in the Ljusnan which runs through the counties of Jämtland and Gävleborg and flows into the Baltic Sea at Ljusne. The power stations along the river account for six per cent of the country's hydroelectric power. In Sweden, dam failures with relatively minor impacts have occurred, for example, in Sysseleback (1973) Noppikoski (1985) and Aitik (2000). In Sysseleback, buildings and roads were destroyed and one person died with as a result of the failure. In Noppikoski, a power station, roads, bridges and forest land sustained damage. In Aitik, the failure did not lead to any significant damage or injury. Another ten smaller dam failures have occurred in dams for hydropower production in Sweden.

3.6.2 Impact assessment

This scenario has been developed on the basis of previously conducted analyses, including *Dam Safety – A pilot project in the Ljusnan* (Elforsk report 05:38, 2006), *Torrents in the Dalälven* (Rescue Services Agency 1996) and the impact descriptions of floods in central Norrland, 2000–2001.

The scenario and analysis have been discussed and agreed upon with representatives from MSB, Svenska Kraftnät, Fortum, Vattenregleringsföretagen and the county administrative boards in Gävleborg and Jämtland.

The impacts of the dam failure would be substantial. Large areas are flooded, and many buildings and much infrastructure are destroyed by the flood waters. The flood carries away roads and railway lines as well as several intersecting bridges, power lines and communications infrastructure. All downstream electrical power production is knocked out. The electricity grid is affected at all system levels, but local and regional

50. Discharge is the amount of water per time unit removed from a reservoir.

grids are hit the hardest. Power shortages may occur in southern Sweden due to limitations in the transfer capacity of the national electricity grid. Transport to and from northern Sweden is greatly reduced, with possible impacts on, for example, industry, medical care and food trade. People caught in the path of the flood may perish. Around 9,000 people live in the risk area for flooding and would need to be evacuated. The flood reaches the nearest community just one hour after the failure occurs. Those that are evacuated will not be able to move back to their homes for a long time. Repair and restoration costs alone are estimated at several tens of billions of SEK. Restoration of dams is a very expensive and time-consuming process. In addition, all companies in the area suffer from a loss of income.

The environment would be affected through the altering of the valley's appearance and possibly even the river's route as a result of the soil mass shifted by the flood. The river, which has been regulated since the 1950s, will subsequently be unregulated. Cultural heritage (ancient monuments, Iron Age tombs, Stone Age settlements, church ruins etc.) would be flooded or washed away.

Several livestock farms would be flooded. The same applies to water treatment plants, dams, petrol stations, industrial areas and an oil storage tank, with the consequent risk of oil and petrol leakage.

Overall, the impacts are assessed to be *very significant* according to the scale in the national risk assessment, primarily due to a considerable amount of valuable property, in the form of built-up areas and infrastructure, being lost. The risk is immediate that many people would die, but this depends on how fast the river valley's risk areas can be evacuated.

3.6.3 Assessment of likelihood

Common causes of dam failures include the drainage capability during high floods being insufficient, or that leaks occur in the actual body of the dam or in its foundations. According to international statistics, the likelihood of a dam failure in high dams⁵¹ is in the order of 0.0001 on an annualised basis (once per 10,000 years) and, of the dams that have been built after 1951, fewer than 0.5 per cent have experienced a failure. The general assessment is that the likelihood of dam failure has become smaller due to the constant development of knowledge and the strengthening of existing dams.⁵²

The failure of only about 20 dams in Sweden is judged to have the potential to result in impacts of the magnitude predicted in this scenario. Based on international statistics, the likelihood of any of these 20 dams failing is 0.002 on an annualised basis, corresponding to the order of magnitude of once in 500 years. This means that the likelihood is assessed to be *medium*.

3.6.4 Uncertainty assessment

For several years, the owners of the dams along the country's eleven largest rivers, in collaboration with Svenska Kraftnät, have developed detailed flow and flood charts for the worst possible dam failures. The assessment of the impacts of the dam failure is based on the ongoing work to raise emergency preparedness in the river valleys, including studies with mapping and flood simulations.⁵³ With regard to

51. i.e. "large dams" according to ICOLD's definition (15 m high).

52. SOU 2012:46. *Dam safety Clear rules and effective supervision*. p. 74, and Elforsk (2006), *Contingency planning for dam failure - A pilot project in the Ljusnan*, p. 5.

53. See Elforsk report 05:38.

the area that would be flooded and the operations that would potentially be hit, the uncertainty in the assessment is deemed *low*.

Uncertainty in the impact assessment is judged to be *medium*. The assessment of the dam failure's economic impacts, however, is solely based on rough estimates and is associated with high uncertainty.

As dam failures in Sweden have not been subject to a systematic inventory, international statistics have been used in the assessment of likelihood. The statistics relate to dams that are higher than 15 metres and are, therefore, not wholly applicable for the assessment of the 20 dams in Sweden, failures of which would result in serious impacts. The uncertainty in the assessment of likelihood is, therefore, judged to be *medium*.

Overall, the uncertainty in the assessments is deemed to be *medium*.

3.7 Scenario – major fire on a cruise ship

It is a clear, yet windy, Friday night in mid-December. The cruise ship MS Freja is on her way from Southampton (United Kingdom) to Gothenburg. With a length of 294 m, a width of 32.3 m and a draught of 7.9 m, it is one of the largest cruise ships to dock at Swedish ports.

On this night, the ship is fully booked, with a total of 3,503 people on board (2,250 passengers and 1,253 crew members). The composition of the passengers is varied; elderly and middle-aged people, families with children and adolescents.

A fierce fire breaks out on board and spreads quickly. The fire originates in the engine room. Safety systems with carbon dioxide and sprinklers are activated, but only have a marginal effect in limiting the spread of the fire. The crew attempt to extinguish the fire themselves, but are not able to bring it under control. This scenario entails the failure of the ship's operational function and electrical equipment. However, communications equipment and emergency lighting continue to function.

The smoke is very toxic, and panic breaks out among the passengers. About two-thirds of them assemble at the muster stations on deck. There is much confusion as to where the other passengers are, and a rumour spreads that many have died.

3.7.1 Thematic background

A fire can occur in all types of vessel, with potentially serious impacts for human life and health, economic values and the environment. Few major fire-related events have occurred on ships within the Swedish search and rescue region. However, some cases stand out, such as the fire disaster on the passenger ferry Scandinavian Star in 1990, where 159 people lost their lives.

According to statistics from the Sea Casualty System's database, on average, 124,000 vessels dock annually in Swedish ports. Over the course of the period 1992–2010, 133 incidents of fire on board were registered in the Swedish economic zone, of which 11 were classified as "serious" or "shipwrecks". Six of these events occurred at sea and five when the ship was moored at the dock.

3.7.2 Impact assessment

The analysis is based largely on an expert workshop that the County Administrative Board of Västra Götaland organised on 19 October 2012, involving representatives from the Swedish Coast Guard, the Swedish Transport Agency, Tjörn Municipality (emergency services), the Swedish Maritime Administration (including the Joint Rescue

Coordination Centre – JRCC), the Pre-hospital and Disaster Medicine Centre (PKMC), the Port of Gothenburg and the Greater Gothenburg Fire and Rescue Service. The scenario had previously been discussed and agreed upon with the Swedish Maritime Administration and the Swedish Defence Research Agency.⁵⁴ The workshop participants were also given the opportunity to comment on the processed results.

This scenario represents an extraordinary event where many lives are threatened. It is estimated that 30 to 500 people will die as a direct result of the scenario. Over 2,500 people are expected to be seriously injured or traumatised and psychologically damaged in the long-term due to the event.

This scenario would lead to severe stress for those involved in the management of the event, particularly in the short term. In general, the scenario only marginally impacts society's functionality.

The event's economic impact may amount to costs of several billion SEK, including damage to the ship, which is worth billions of SEK. The scenario is also expected to result in significant costs to the municipality (in this case the City of Gothenburg), which subsequently can be partially recovered from the State, the shipping company and its insurers.

The resulting investigation may lead to several people in decision-making positions being required to resign their posts. This is considered unlikely, however, and would mainly be relevant if gross misconduct was revealed.

The scenario is expected to have limited impacts for nature and the environment, and minimal impact on Sweden's reputation internationally. If the event is handled efficiently, the image of the country may even be strengthened.

Overall, the scenario is judged to have *very significant* impacts.

3.7.3 Assessment of likelihood

The sequence of events in the scenario is considered reasonable, given that fires do occur.

Nowadays, there are considerably fewer engine room fires breaking out. Following the fire on Prinsessan Ragnhild in 1999, all passenger ships must be fitted with local point protection which allows many engine room fires to be extinguished at an early stage.

The number of cruise ships docking in Sweden has increased significantly in recent years, beating previous record numbers each year. Approximately 70 cruise ships were added to Gothenburg's complement during 2012. The corresponding figure for Stockholm was around 300. Most docking takes place during the summertime, resulting in the likelihood for fires being lower in the winter.

Statistics show that the likelihood of a serious fire occurring aboard all ships in the Swedish search and rescue region is 0.58 per year.⁵⁵ This implies that a fire occurs once in 1.7 years. The likelihood that a fire would break out on a specific vessel is $4.7 \cdot 10^{-6}$.

54. The development of this scenario was inspired by real events and the forthcoming docking of cruise ships at the Port of Gothenburg. The fire's course of events is based on the fire that happened on the Norwegian ship *Hurtigruten* (2011).

55. MSB (2010) Maritime Search and Rescue, RITS, Proposal for a new concept (10/06/2010).

Each year around 700 cruise ships arrive in Sweden and Copenhagen.⁵⁶ This statistic does not include ferry traffic or cruise ships that only operate in Swedish territorial waters. Assuming that the likelihood of a fire breaking out is equally as high for cruise ships as for other vessels, the likelihood of fire occurring on a cruise ship is then judged to be 0.003 per year, which corresponds to once in 300 years, or *low* likelihood.

3.8 Uncertainty assessment

The uncertainty of the assessment of likelihood indicating that a cruise ship fire would occur within the Swedish search and rescue region once in 300 years is assessed as *medium*.

Uncertainty in the impact assessment is judged to be *medium*. The greatest uncertainties are found in the assessments of the magnitude of the economic impacts⁷, the number of fatalities, severely injured or ill, and the extent and impact of the spread of rumours. In these cases, the uncertainty is assessed to be high.

Overall, the uncertainty in the assessments is deemed to be *medium*.

56. Copenhagen is included here as vessels navigate Swedish territorial waters or just outside of these.

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Appendix 1 – Scenario variables

Appendix 1 – Scenario variables

Location on the map (geographical location)

Season (spring, summer, winter, autumn)

Weather (temperature, precipitation, wind)

Weekday, holidays

Time of day

Warning time (none – months)

Implemented preventive and preparatory measures (that which is done during the warning period)

Consequential events (triggered by the primary event)

Terrain type in the area (urban, mountain, plain, forest, etc.)

Accessibility (logistics, including existing infrastructure)

Population density (in the affected area)

Expected duration of the event (acute phase and subsequent phase until a new state of normality is reached)

Administrative complexity (number of affected municipalities, counties, county councils, countries)

Coordination needs for crisis management stakeholders (that need to collaborate)

Size of the affected area (square metres or blocks, municipality, county)

Vulnerable objects/values (e.g. cultural environments, traffic nodes, hospitals, symbols)

Direct impacts for human life and health (that cannot be influenced)

Direct impacts for basic needs (e.g. water, heat, medicine)

Direct impacts for critical infrastructure/vital societal functions

Direct impacts for property and economic values (e.g. structures, livestock)

Direct impacts for daily life (which are not life-threatening, e.g. transportation, financial services, childcare, schools, elderly care, food)

Direct environmental impacts (e.g. ecosystem, arable land, forest)

