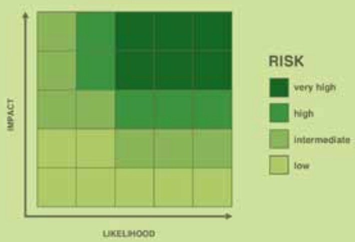
Federal Office
of Civil Protection and
Disaster Assistance

Method of Risk Analysis for Civil Protection



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English

WISSENSCHAFTSFORUM

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VOLUME 8

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Provinzialstraße 93, D-53127 Bonn
Telephone: +49-(0)228 99-550-0, Fax: +49-(0)228 99-550-1620
poststelle@bbk.bund.de

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Preface

On the basis of the "New strategy for the protection of the population in Germany" (2002), the federal states (Länder) created in the years of 2004/2005 individual hazard estimations following a uniform structure. The hazard estimations included technical, anthropogenic and natural hazards as triggering events for large-scale and/or long-lasting or intractable damage situations. The German federation (Bund) supported the work of the federal states by contributing specialist additions to such hazards which can occur without specific local reference (e. g. epidemics, failure of critical infrastructures). The Federal Office of Civil Protection and Disaster Assistance (BBK) evaluated the sixteen contributions of the federal states and created, by using additional findings, the Joint Hazard Estimation from a civil protection perspective excluding police and military. For the first time in more than 50 years of civil protection in Germany, the Joint Hazard Estimation, whose integral part are the hazard estimations of the federal states, provides a methodologically uniform survey comprising potential hazards to state, society and economy in Germany.

In September 2006, the open and trusting cooperation of the federation and the federal states in the context of the Joint Hazard Estimation lead to the decision to continuously carry on with this work. That is why BBK was asked to develop a method which allows to reach the target given by the Conference of the Ministers of the Interior of the federal states in 2002, namely to carry out risk analyses by paying special attention to the factors of likelihood and impact. According to the wish of the federal states, BBK has developed a pragmatic method which can be easily implemented for risk analysis for civil protection in the Federal Republic of Germany. Thanks to this method, it is possible to analyse any kind of risk at all administrative levels. The method is presented in this document. Additionally, BBK is currently developing guidelines for the implementation of this method, tailored to particular needs of different target groups.

I would like to take the opportunity to thank the employees of BBK as well as the experts of our national and international networks who have contributed to and supported the development of the method of risk analysis for civil Protection.

Christoph Unger
President

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Introduction

Risk analysis is the central basis of civil protection and the core element of risk management. With reference to a defined area (Federal Republic of Germany, Federal State, administrative district, municipality), risk analysis allows to determine, in a systematic way, the impact (=extent of damage) which is to be expected if different hazardous events occur. It also allows the graphic comparison of risks related to different hazards. On the basis of these findings, it is possible to take directed and efficient measures to protect the population and its means of existence. Such measures include, for example, actions to prevent hazards and to adapt to changing hazards, the reduction of exposure and vulnerability of different subjects of protection as well as the preparation to a quick and effective handling of possible damaging events thanks to the flexible and efficient use of available capabilities.

The guideline at hand presents a method of risk analysis for civil protection which was developed by BBK. During the development of the method, not only findings from the development of the Joint Hazard Estimation but also research work of BBK on methods of risk analysis as well as results of the professional exchange with several federal authorities[1], international partner

1 Federal Office for Building and Regional Planning, Federal Agency for Cartography and Geodesy, Federal Office of Information Security, Federal Office for Radiation Protection, Federal Office for Consumer Protection and Food Safety, Federal Office for Geosciences and Natural Resources, Federal Institute of Hydrology, Institute for Federal Real Estate – Section Federal Forest, Federal Office for Agriculture and Nutrition, Federal Institute for Materials Research and Testing, Federal Highway Research Institute, Federal Agency for Technical Relief, Federal Institute for Risk Assessment, Federal Criminal Police Office, German Weather Service, Robert-Koch-Institute, Federal Statistical Office, Federal Environment Agency.

authorities[2] and academia[3] were taken into consideration. Furthermore, the methodical approach is in line with the international standard on risk management and risk analysis.[4] Aim of the guideline is to support the practical application of the risk analysis method for civil protection. In this context, it was deliberately abstained from entering all possible details and alternatives of risk analysis and from presenting and discussing them here. A glossary of the central terms of risk analysis and risk management is provided in Appendix 1.

The following survey summarises the most important framework conditions for the application of the risk analysis method for civil protection:

2 CA: Home Office, Integrated Hazard Assessment Unit; Department of Public Safety and Emergency Preparedness, CH: Bundesamt für Bevölkerungsschutz (BABS), FI: Geological Survey of Finland, FR: Ministère de l'intérieur, de l'outre-mer et des collectivités territoriales, Direction de la planification de sécurité nationale; NL: Ministerie van Binnenlandse Zaken en Koninkrijksrelaties; Provincie Gelderland, NO: Direktoratet for samfunnssikkerhet og beredskap (DSB), SE: Swedish Emergency Management Agency (SEMA), UK: Cabinet Office (Civil Contingency Secretariat); US: Department of Homeland Security (DHS); United States Government Accountability Office (GAO), as well as at a multilateral level also with AT, BG, CH, CZ, ES, FI, FR, GR, HU, LT, NL, PL, SE, SI, SK.

3 Eidgenössische Technische Hochschule Zürich (ETH), Institute for the Protection and Security of the Citizen (IPSC), Joint Research Centre der EU-Kommission (JRC), et al..

4 Cf. ISO 31000 (2009), ISO 31010 (2009).

FRAMEWORK CONDITIONS

1. Integral elements of risk are likelihood and impact. Likelihood refers to a hazardous event of a certain intensity. Impact refers to damages to various subjects of protection that has to be expected if the hazardous event occurs.
2. During the risk analysis process, a well-balanced measure of scientific demand on the one hand and pragmatic approach on the other hand has to be found. Whenever there is a lack of statistical/scientific findings, it should be possible to compensate such deficits in knowledge (initially) by well-founded assumptions and estimations.[5] Here, involvement of (local) experts ensures the highest possible degree of reliability.
3. All steps of the risk analysis process have to be carefully documented in order to guarantee the traceability of the results.
4. It is possible to limit the analysis to those risks that would confront an administrative level with such great challenges that the support by a superior administrative level is reasonable, in order to cope with the damage or to take respective preventive measures. To follow the proven logic of the integrated relief system in the Federal Republic of Germany, the individual determination of corresponding threshold values by the analysts is possible.
5. Risk analysis should also consider hazards that have their origin outside the reference area as they still may have an impact on the own area of responsibility. To this end, the professional exchange with neighbouring administrative units as well as subordinate/superior administrative levels is recommended.
6. Risk analysis for civil protection is an ongoing task. The applied method must allow for being optimised and adapted to new findings/framework conditions at any time.
7. The method is an instruction for the practical accomplishment of risk analysis. The evaluation and thus the appreciation of the risk analysis results and their implementation in administrative and/or political acts are special (later) steps within the risk management process.
8. Thus, risk analysis is no end in itself but a partial aspect of a comprehensive risk management, which consists of analysis, evaluation, treatment and monitoring of risks as well as of directives for the involvement of experts and persons concerned.[6]

Survey 1 **Framework conditions for the application of the risk analysis method in civil protection**

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5 Uncertainty is the determinant characteristic of risk. Even in the area of technical analyses – e. g. in the context of event tree analyses according to DIN 25 419 – the same principle is applied. Cf. ibid. no. 6.1.

6 There are numerous approaches to risk management. This guideline is based on the status quo of the international discussion, which is reflected by the ISO 31000 “Risk management: principles and guidelines”.

2

Procedure

The aim of risk analysis for civil protection is the comparative representation of a variety of risks, caused by different kinds of hazards, in a risk matrix (Figure 1) as a basis for the planning process in civil protection. The use of a risk matrix corresponds to the international standard[7] and has stood the test of time in practice.[8]

As a basis for the comparative representation of risks within the risk matrix, the subsequently introduced steps of risk analysis have to be followed for all hazards of interest. The five-stage classification of the matrix is reflected by corresponding analysis steps for the determination of likelihood (chapter 2.3) and impact (chapter 2.4).

The creation of reliable risk analyses according to this procedure requires the integration of manifold information and is advantageously done on the basis of available data and by considering interdisciplinary findings. To this end, the inclusion of expertise and data from sectoral agencies is of utmost importance.[9] It can be specifically supplemented by expertise from science, economy and other areas. Justified assumptions/expert assessments can initially compensate for deficits in scientific findings. The development of the results of the risk analysis have to be documented accurately so that they can be retraced at any time.

7 Cf. ISO 31010 (2009), p. 82 ff.

8 Examples: CH, NL, UK use a comparable risk matrix in the context of their risk analyses for civil protection.

9 At federal level, BBK has initiated the "Network Risk Analysis in Federal Agencies", in order to integrate existing data and expert knowledge from various professional areas into the risk analysis process. Aim of the network is to generate joint and well-founded findings about risks in Germany.

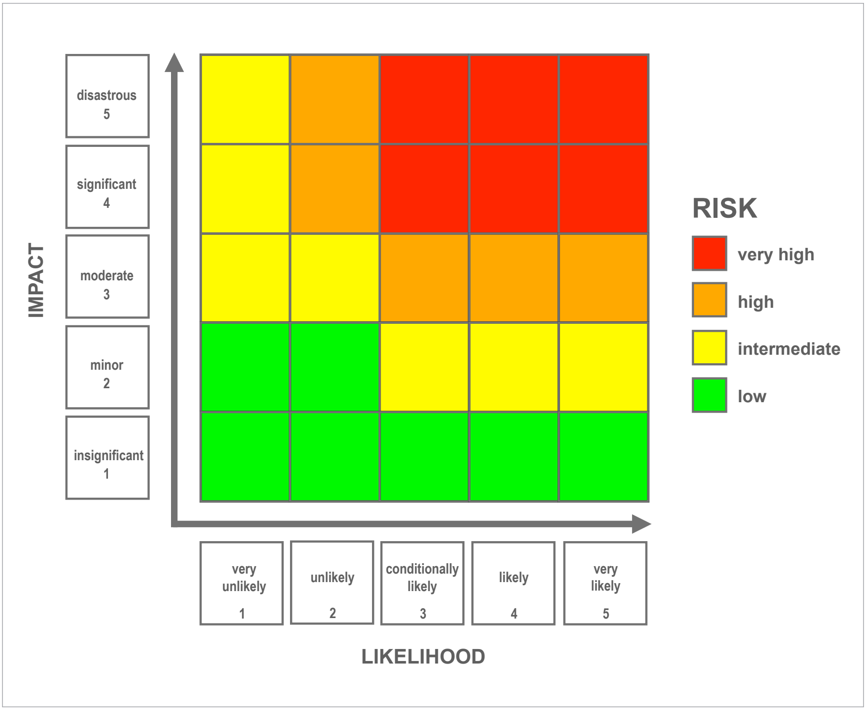

Fig. 1 Risk matrix

2.1 Description of reference area

Risk analysis for civil protection always refers to a clearly identifiable territorial reference area such as the Federal Republic of Germany, a federal state, an administrative district, a rural district or a community. For the chosen reference area impact is determined according to the expected consequences if a certain hazardous event occurs. In this context, damage to subjects of protection as well as immaterial impact is taken into consideration.

Accordingly, in the first step of the risk analysis process, a detailed description of the reference area is compiled. It includes, e. g., information related to the general geography of the reference area (e. g. climate, land use) its population (e. g. number of inhabitants, population density), environment (e. g. protected areas), economy (e.˘g. economic performance, business tax receipts) and supply (e. g. main infrastructures of electricity and drinking water supply). To this end, at least the information listed in table 1 should be included, as it provides an important basis for the later determination of the expected impact (chapter 2.4).

CATEGORY	INFORMATION	POSSIBLE SOURCES OF INFORMATION
MAN	Number of inhabitants	• Statistical offices • Federal Institute for Building, Urban and Rural Research • Registry offices
	Population density	
	Number of households	
ENVIRON-MENT	Protected areas[10]	• Federal Agency for Nature Conservation • Environment offices
	Agricultural land	• Statistical offices • Offices for agriculture
ECONOMY	Economic performance	• Statistical offices • Economic authorities
	Business tax receipts	
SUPPLY	Infrastructures of water supply	Economic authorities Infrastructure suppliers
	Infrastructures of electricity supply	Economic authorities Infrastructure suppliers
	Infrastructures of gas supply	Economic authorities Infrastructure suppliers
	Infrastructures of telecom-munication	Economic authorities Infrastructure suppliers
IMMATERIAL	Cutural assets	Authorities for preservation

Tab. 1 **Description of the reference area**

If possible, the description of the reference area should be complemented by corresponding maps. To this end, available maps from other areas (e. g. official web-GIS-applications) can be included.

10 According to the Federal law on nature conservation (BNatSchG), nature reserves, national parks, biosphere reserves, landscape conservation areas and nature parks belong to the protected areas.

2.2 Selection of hazard and description of scenario

In the second step of the risk analysis process, the type of hazard, for which risk has to be determined, is defined. To this end, the index number catalogue of the Joint Hazard Estimation (appendix 2) can be used as a basis. Based on the selected hazard, a scenario has to be developed which serves as starting point for the risk analysis. The scenario must describe the event clearly and in sufficient detail in order to provide the basis for the assessment of likelihood and impact as precise and consistent as possible. Therefore, it is necessary to describe type, spatial dimension, intensity and duration of the expected incident. Wherever possible/available, scientific/statistical findings should be included. Deficits in knowledge can (initially) be compensated by well-founded assumptions and expert assessments.

For some types of the hazards scientifically proved assumptions/prognoses concerning their expected intensity are already available. They just have to be transferred to the reference area in question. The justification concerning the selection of the scenario parameters must be accurately documented. Table 2 provides examples of parameters and central questions for the scenario description:[11]

As long as an event can be measured (e. g. floods, earthquakes, release of hazardous substances), the usual units of measurement are used (e. g. HQ 100, Richter scale Magnitude 6, release of 100 kg of chlorine). If a qualitative description is necessary, the reference to real incidents is recommended in order to allow third parties to understand the assumptions and to make the further analysis more illustrative (example: "Release of hazardous substances on 12 December 00 in the city of XY").

11 In Denmark, templates are used for scenario-based risk and vulnerability analyses. The Danish civil protection authority DEMA offers respective templates in English on its website: http://www.brs.dk/fagomraade/tilsyn/csb/Eng/RVA/the_RVA_model.htm (05.03.2010).

PARAMETER	CENTRAL QUESTIONS
Hazard	• Which type of hazardous event is considered?
Scene of occurrence	• Where does the event take place?
Spatial dimension	• Which area is affected by the event?
Intensity	• How strong is the event?
Time	• When does the even take place? (time of year/time of day, if applicable)
Duration	• How long does the event and its direct impact last?
Development	• How does the event evolve?
Notice time for warning	• Is the event expected? • Is the population able to prepare for the event? • Are public authorities able to prepare for the event?
Who is affected?[12]	• Which subjects of protection are affected by the event? (persons, environment, objects etc.)
Reference incidents	• Have there been comparable events in the past?
Further information	• How well prepared are the responsible authorities/relief units/ helpers? • Findings concerning the damage susceptibility and/or robust-ness of the affected persons/elements. • What else is important for the scenario, but has not yet been gathered?

Tab. 2 **Parameter and central questions for the description of the scenario**

12 Here, it is only described who/what is affected by the event. The resulting consequences will be determined in a separate, later step of the risk analysis process (see chapter 2.4).

2.3 Assessment of likelihood

In the third step of the risk analysis process, the likelihood of the previously defined scenario has to be determined. For its classification, a five-step scale is used. The classification comprises – in analogy to the later presentation in the risk matrix – the categories 1 (“very unlikely”) to 5 (“very likely”), to which a corresponding statistical likelihood is assigned. Table 3 shows an example of a respective classification.

VALUE	CLASSIFICATION	… per year	1 x in … years
5	very likely	≤ 0.1	10
4	likely	≤ 0.01	100
3	likely to a limited extent	≤ 0.001	1,000
2	unlikely	≤ 0.0001	10,000
1	very unlikely	≤ 0.00001	100,000

Tab. 3 **Exemplary model for the classification of the probability of occurrence**

Note: The classification relates to statistical annuality values. Thus a flood, which happens every 100 years (HQ100), is an incident which, on statistical average, occurs once every 100 years. That does, however, not mean that such an event cannot be followed by another one of the same scale within the next 100 years.[13]

The example of a classification, presented in table 3, can be used for all administrative levels. If necessary, it can also be modified. If results of various administrative units at the same level are supposed to be compared or summarised at a superior level, the fact that the use of differing threshold values for classification leads to different results, should be paid attention to.

13 The “hundred year flood” of the river Rhine in the years 1993 and 1995 prooved that this can happen.

When likelihood is determined, once again, available scientific/statistical findings should be taken into consideration. Deficits in knowledge can initially be compensated by justified assumptions/expert assessments. The involvement of professional authorities and/or research institutions, which have (scientific) findings about the probability of occurrence, is recommended.

If statistical data about the likelihood of the respective event is not available, a qualitative correlation via the classification "very likely" (5), "likely" (4), "conditionally likely" (3), "unlikely" (2) and "very unlikely" (1) is possible. The derivation of the classification of likelihood has to be documented. By doing this, it is possible to retrace and/or adapt the assumptions, if the analysis is updated/checked.

2.4 Assessment of impact

In the fourth step of the risk analysis process, the impact that has to be expected if the event previously defined in the scenario occurs, is assessed. By doing this, the impact on different categories of subjects of protection is considered. This only refers to negative consequences, which can be summarised under the generic term "damage". The determination of the expected impact requires the selection of appropriate impact parameters[14] as well as the definition of appropriate threshold values for the classification of impact related to each impact parameter. The methodological procedure is explained in detail below:

Selection of damage parameters

Table 4 provides an exemplary selection of impact parameters that can be used to assess the expected impact. Here, 20 general impact parameters are listed, of which four each belong to the categories MAN, ENVIRONMENT, ECONOMY, SUPPLY and IMMATERIAL. These parameters can be considered for any kind of hazard as they represent those elements which, as a general rule, are damaged (to various degrees though). They deliberately represent an abstraction of complex cause and effect relations, in order to come to comprehensible statements with reasonable effort. The impact parameters in total represent the impact which is expected when the previously defined event takes place. Their identification is done by a capital letter for the corresponding category as well as a subscript number, which refers to the parameter in question.

14 Impact parameters are characteristics for damage to different subjects of protection that is expected if a hazardous event occurs within a reference area.

The impact parameters shown here represent a reasonable selection of possible parameters. They suffice to carry out a risk analysis. Of course, they can be analysed in more detail and complemented by additional parameters.[15]

Category	Abbre-viation	Damage parameter	Description/ Operationalisation	Unit
MAN	M1	Fatalities	Persons who die due to the incident in the reference area	Number
	M2	Injured	Persons who are injured due to the incident in the reference area or who become ill during/after the incident so that they need treatment by doctors or the health system (here long-term consequences/long-tail claims have to be included)	Number
	M3	Persons in need longer 14 days	Persons in need for public aid for physical survivla for more than 14 days	Number
	M4	Persons in need up to 14 days	Persons in need for public aid for physical survival up to 14 days	Number
ENVIRON-MENT	U1	Impairment of protected area	Protected areas which are damaged due to the incident (protected areas, national parks, biosphere reservations, land-scape protection areas, natural parks)	ha
	U2	Impairment of water bodies	Living space in surface waters or in the sea which are damaged due to the incident (rivers, canals, brooks, lakes, ponds)	km/ha
	U3	Impairment of ground water	Ground water which is contaminated due to the incident	ha
	U4	Impairment of agricultural land	Agricultural land which is damaged due to the incident	ha

15 In many publications there are references to the differentiation of impact in risk analyses.A selection of impact parameters to be used in the context of flood action plans can be provided e. g. by the responsible authorities for flood prevention (cf. e. g. part 5 of the flood action plan of Lippe, available on http://www.stua-lp.nrw.de/map/p/hwlippe/main/07_Bericht/05/tr/Frame.html (05.03.2010). Cf. also DVWK (1985), p. 32-50).

Category	Abbre-viation	Damage parameter	Description/ Operationalisation	Unit
ECONOMY	W1	Physical damage	Sum of the replacement value of the direct material damage (destruction etc.)	Euro
	W2	Consequential damage	Sum of the indirect damage (loss of supply, delivery interruptions etc.)	Euro
	W3	Loss of econom-ic performance	Loss of economic performance, due to the incident	Euro
	W4	Loss of econom-ic profitability	Business tax losses due to the incident	Euro
SUPPLY	V1	Disruption of water supply	Duration and spatial extent of the disruption, number of persons affected	Number, hours/days
	V2	Disruption of energy supply	Duration and spatial extent of the disruption, number of persons affected	Number, hours/days
	V3	Disruption of gas supply	Duration and spatial extent of the disruption, number of persons affected	Number, hours/days
	V4	Disruption of telecommunica-tion	Duration and spatial extent of the disruption, number of persons affected	Number, hours/days
IMMATE-RIAL	I1	Impact on public order and safety	Extent of the consequences of the incident on public safety (e. g. public protests, violence against persons/objects)	Extent
	I2	Poitical implications	Extent of the consequences of the incident on the political-administrative sector (e. g. call for state actions, public calls for resignations)	Extent
	I3	Psychological implications	Extent of the loss of trust in public authorities (e. g. government, adminis-tration)	Extent
	I4	Damage to cultural assets	Cultural assets according to the Hague Convention which is damaged due to the incident	Number and degree of damage

Tab. 4 **Examples of impact parameters**

Definition of threshold values

Additionally, it is necessary to define adequate threshold values to classify impact separately for each impact parameter. In analogy to the classification of likelihood, again five categories are applied, ranging from “insignificant” (impact value 1) to “disastrous“ (impact value 5). Corresponding threshold values have to be defined for the reference area in question. Reference to available regulations, scientific results and reference events facilitates the definition of adequate threshold values. Their development has also to be documented.

Threshold values for the classification can, for example, be derived from available regulations[16] and scientific findings as well as from the comparison with systematic procedures that have stood the test of time in practice in other areas of responsibility as well as in other states (e. g. CH, NL).

The following tables can serve as templates for impact classification. They can be adapted to the individual requirements of the user in question:

16 The “Twelfth regulation for the implementation of the Federal Law for Emission Prevention (BIMSchV 12 2000)”, appendix VI, announcements, contains threshold values for notifiable incidents, which can be used as a basis for classification. The classification of the economic damage can, e. g., be based on the criteria of the European Social Fund. In the regulation (EU) no. 2012/2002 of the Council of 11 November 2002 for the establishment of the Solidarity Fund of the European Union, “large-scale catastrophes” correspond to damage whose estimated direct costs amount to more than 3 billion or 0.6 % of the Gross Domestic Product of the state in question (cf. § 2 (2) of the regulation).

Classification		MAN			
Value	in words	Fatalities	Injured	Persons in need longer than 14 days	Persons in need up to 14 days
5	disastrous	> ___	> ___	> ___	> ___ persons for > ___ hours/days
4	significant	___ - ___	___ - ___	___ - ___	___ - ___ persons for ___ - ___ hours/days
3	moderate	___ - ___	___ - ___	___ - ___	___ - ___ persons for ___ - ___ hours/days
2	minor	___ - ___	___ - ___	___ - ___	___ - ___ persons for ___ - ___ hours/days
1	insignificant	≤ ___	≤ ___	≤ ___	≤ ___ persons for ≤ ___ hours/days

Tab. 5 **Model for the classification of the category MAN[17]**

Classification		ENVIRONMENT			
Value	in words	Impairment of protected area	Impairment of water bodies	Impairment of ground water	Impairment of agricultural land
5	disastrous	long term > ___ ha or temporarily > ___ ha	river > ___ km or lake > ___ ha or sea > ___ ha	> ___ ha	long term > ___ ha or temporarily > ___ ha
4	significant	long term > ___ - ___ ha or temporarily > ___ - ___ ha	river > ___ km or lake > ___ ha or sea > ___ ha	___ - ___ ha	long term > ___ - ___ ha or temporarily > ___ - ___ ha
3	moderate	long term > ___ - ___ ha or temporarily > ___ - ___ ha	river > ___ km or lake > ___ ha or sea > ___ ha	___ - ___ ha	long term > ___ - ___ ha or temporarily > ___ - ___ ha
2	minor	long term > ___ - ___ ha or temporarily > ___ - ___ ha	river > ___ km or lake > ___ ha or sea > ___ ha	___ - ___ ha	long term > ___ - ___ ha or temporarily > ___ - ___ ha
1	insignificant	long term ≤ ___ ha or temporarily ≤ ___ ha	river ≤ ___ km or lake ≤ ___ ha or sea ≤ ___ ha	≤ ___ ha	long term ≤ ___ ha or temporarily ≤ ___ ha

Tab. 6 **Model for the classification of the category ENVIRONMENT**

17 Remark: As a matter of principle, the loss of human lives is tragic. The classification only serves the assessment of impact and the later risk value. It does not represent a value judgement.

Classification		ECONOMY			
Value	in words	Physical damage	Consequential damage	Loss of economic performance	Loss of economic profitability
5	disastrous	> ___ €	> ___ €	> ___ €	> ___ €
4	significant	___ - ___ €	___ - ___ €	___ - ___ €	___ - ___ €
3	moderate	___ - ___ €	___ - ___ €	___ - ___ €	___ - ___ €
2	minor	___ - ___ €	___ - ___ €	___ - ___ €	___ - ___ €
1	insignificant	≤ ___ €	≤ ___ €	≤ ___ €	≤ ___ €

Tab. 7 **Model for the classification of the category ECONOMY**

Classification		SUPPLY			
Value	in words	Disruption of water supply	Disruption of energy supply	Disruption of gas supply	Disruption of tele-communication
5	disastrous	> ___ persons for > ___ hours/days	> ___ persons for > ___ hours/days	> ___ persons for > ___ hours/days	> ___ persons for > ___ hours/days
4	significant	___ - ___ persons for ___ - ___ hours/days	___ - ___ persons for ___ - ___ hours/days	___ - ___ persons for ___ - ___ hours/days	___ - ___ persons for ___ - ___ hours/days
3	moderate	___ - ___ persons for ___ - ___ hours/days	___ - ___ persons for ___ - ___ hours/days	___ - ___ pers ons for ___ - ___ hours/days	___ - ___ persons for ___ - ___ hours/days
2	minor	___ - ___ persons for ___ - ___ hours/days	___ - ___ persons for ___ - ___ hours/days	___ - ___ persons for ___ - ___ hours/days	___ - ___ persons for ___ - ___ hours/days
1	insignificant	≤ ___ persons for ≤ ___ hours/days	≤ ___ persons for ≤ ___ hours/days	≤ ___ persons for ≤ ___ hours/days	≤ ___ persons for ≤ ___ hours/days

Tab. 8 **Model for the classification of the category SUPPLY**

Classification		IMMATERIAL			
Value	in words	Impact on public order and safety	Poitical implications	Psychological implications	Damage to cultural assets
5	disastrous	Extent: ________	Extent: ________	Extent: ________	Extent: ________
4	significant	Extent: ________	Extent: ________	Extent: ________	Extent: ________
3	moderate	Extent: ________	Extent: ________	Extent: ________	Extent: ________
2	minor	Extent: ________	Extent: ________	Extent: ________	Extent: ________
1	insignificant	Extent: ________	Extent: ________	Extent: ________	Extent: ________

Tab. 9 **Model for the classification of the category IMMATERIAL**

If results of various administrative units at the same level are supposed to be compared or summarised at a superior level, the fact that the use of different threshold values for impact classification leads to different results has to be taken into account.

Classification of the impact parameters for the categoriesMAN, ENVIRONMENT, ECONOMY and SUPPLY can be done via quantitative ranges of values, which have to be defined by the user of the method. The classification of the impact parameters for the category IMMATERIAL, however, can only to some extent be done in a quantitative way. Thus, for example, with regard to impact on public order and safety, the number of the affected administrative units within the reference area could be considered.[18]

18 Example: Reference area "federal state X" classifies the impact of the incident on public order and safety as "significant" (value 4), when, due to the incident, in 10-20 % of its administrative districts considerable difficulties in maintaining public order and safety can be expected.

Definition of impact values

The definition of impact values for the individual impact parameters is the decisive step within the risk analysis process. That is why the inclusion of expertise from a variety of areas is highly recommended in order to reach reliable statements in a joint effort.

For each impact parameter, the impact that has to be expected if the incident described in the scenario takes place, is assessedbased on the prior classification. The respective impact parameter is assigned an impact value. In this context, the consideration of reference events is recommended.[19] Factors which influence the extent of impact, such as vulnerability, have to be considered.[20] The resulting impact values and their derivation have to be documented.

The total impact value is then determined by a simple arithmetic operation.The classification values of the examined impact parameters are added and then divided by their number. Table 10 presents an example of this operation.

Note: It is possible to attribute different weights to the impact parameters in order to reflect differing priorities. By doing this, individual values of the parameters (and indirectly also aversionfactors[21]) can be taken into consideration. The principle is simple: The impact value, which should have more significance, is counted several times. The divisor for the calculation of the impact value has to be increased accordingly, in order to still use the risk matrix. If the results from

19 As a general rule, the evaluation of past (extreme) events is well documented. The reference events and their impacts do not necessarily have to have happened within reference area at question. The Emergency Events Database EM-DAT of the WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED) can, e. g., serve as a a starting point .The database covers technical disasters (including transport accidents) as well as natural disasters: www.em-dat.net/ (05.03.2010).The incidents for Germany can be filtered via the function “country profiles”.

20 Whenever experts are involved, the consideration of factors, which influence the damage, happens automatically.

21 The phenomenon to attach higher significance to possible incidents with a greater extent of damage than necessary against the background of the corresponding damage expectation value, a fact which can be empirically observed in many situations and be theoretically justified, is referred to as risk aversion (according to the Federal Office for Civil Protection, Switzerland, 2007).

a variety of administrative units are compared at the same level or summarised at a superior level, however, attention should be paid to the fact that different weighing of impact parameters leads to different results.

Category	Impact parameter	Unit	Expected impact (example)	Abbre-viation	Impact value (example)
MAN	Fatalities	Number	15	M1	2
	Injured	Number	120	M2	2
	Persons in need longer 14 days	Number	0	M3	1
	Persons in need up to 14 days	Number	120.000	M4	3
ENVIRON-MENT	Impairment of protected area	ha	500 (temporarily)	U1	2
	Impairment of water bodies	km/ha	none	U2	1
	Impairment of ground water	ha	none	U3	1
	Impairment of agricultural land	ha	none	U4	1
ECONOMY	Physical damage	Euro	4 billion	W1	5
	Consequential damage	Euro	currently not quantifiable	W2	1
	Loss of economic performance	Euro	currently not quantifiable	W3	1
	Loss of economic profitability	Euro	currently not quantifiable	W4	1
SUPPLY	Disruption of water supply	Hours/days, number	none	V1	1
	Disruption of energy supply	Hours/days, number	230.000, 3 days	V2	5
	Disruption of gas supply	Hours/days, number	none	V3	1
	Disruption of telecommunication	Hours/days, number	125.000, up to 1 day	V4	3

Category	Impact parameter	Unit	Expected impact (example)	Abbre-viation	Impact value (example)
IMMATE-RIAL	Impact on public order and safety	Extent	none	I1	1
	Poitical implications	Extent	none	I2	1
	Psychological implica-tions	Extent	none	I3	1
	Damage to cultural assets	Number and degree of damage	3 significantly damaged	I4	3
				Sum:	37
				divided by number of impact parameters:	20
				Total impact value:	**1,9**

Tab. 10 **Impact values and total impact value (example). The listed values/information were chosen at random, they only serve the purpose of illustration**

Note: All impact parameters should always be considered to determine the overall impact value.[22] Even if one or several impact parameter(s) are not expected to suffer any damage, the parameter(s) are nevertheless assigned the value 1 (insignificant), the more so as damage cannot entirely be excluded. Generally, the method can be applied with individual impact parameters and threshold values defined by the responsibleanalysts. Moreover, a more detailed analysis is always possible.

22 Reference: People in need should only be referred to one of the two categories, i. e. "People in need beyond 14 days" (M3) are not included in "People in need up to 14 days" (M4).

2.5 Identification and visualisation of risk

The result of the risk analysis is visualised with a risk matrix, into which the risk, determined by the factors "likelihood" and "impact", is entered as a point (cf. Figure 2).

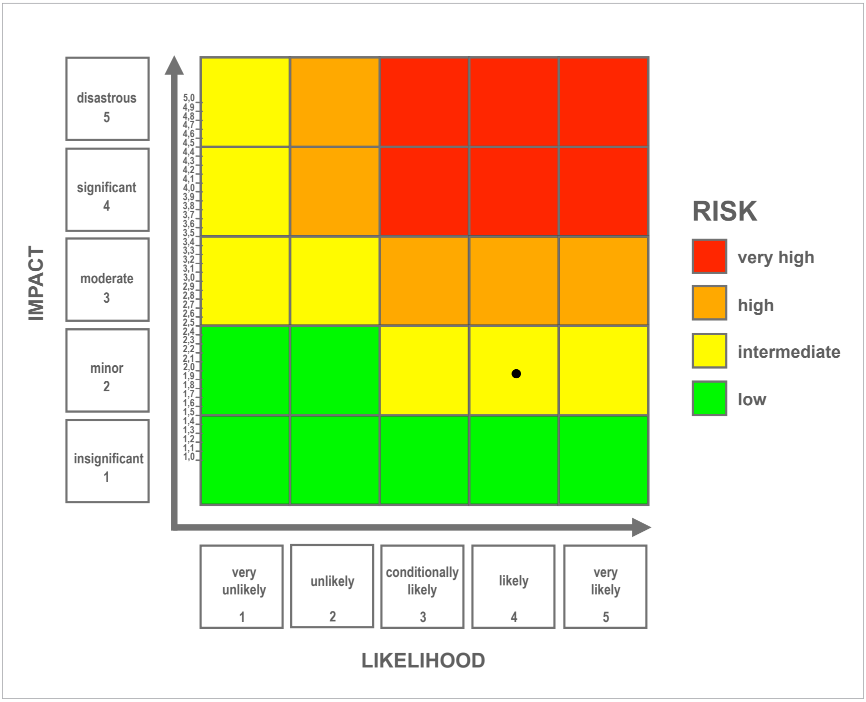

Fig. 2 Visualisation of the detected risk by a point in the matrix (as an example of likelihood 4 and impact 1.9)

While the classification concerning the likelihood of an incident of a special intensity always leads to a natural (whole) number from one to five, the differentiation of the impact by decimal figures with a decimal place is finer.

The aim of risk analysis for civil protection is a comparative representation of a variety of risks related to various types of hazards (scenarios) in a risk matrix (cf. Figure 3 as an example).[23] To this end, the steps of the risk analysis process introduced here, have to be followed for each relevant hazard. Initial point for this procedure are corresponding scenarios for different hazards and likelihoods.

This information can serve as decisions basis in risk management, emergency planning and crisis management, including the prioritisation of measures for the minimisation of risks as well as the preparation for inevitable incidents and their handling.

Risk analysis for civil protection is an ongoing task. The selection of the examined scenarios and subjects of protection can be subject to political requirements. Furthermore, hazards, susceptibility to damage and other factors are changing over time. Therefore, findings, data and systematic procedure must be regularly checked, updated and possibly adapted to new framework conditions. The documentation of the systematic procedure as well as of the used data and assumptions is important, in order to guarantee the traceability of the risk analysis outcomes. Furthermore, a transparent and systematic procedure increases the acceptability of the results.

23 In NL and UK, national risk analyses are carried out annually. The results are presented in such a matrix. While method and results of British risk analysis are classified and made available to the public only in a very general form (cf. National Risk Register, 2008), they are to a large extent available to the public in the Netherlands (cf. Ministerie van Binnenlandse Zaken en Koninkrijksrelaties 2008).

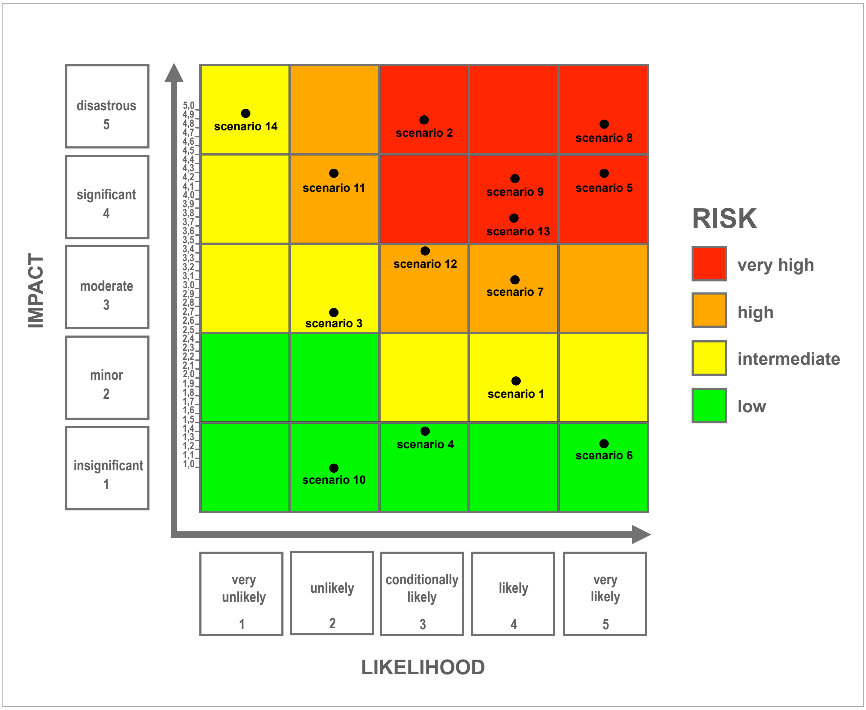

Fig. 3 Comparative representation of a variety of risks in the matrix (as an example)

3

Risk Management

Risk analysis is no end in itself but one aspect of a comprehensive risk management. The process of risk management is usually presented as a cycle, because, after the implementation of measures, an assessment is carried out to find out whether the intended aim has been achieved:

Fig. 4 Risk analysis as a central component of risk management (based on ISO 31000)

Within the context of risk management, one of the tasks of the authorities responsible for civil protection is to provide reliable information about hazards, risks and available capabilities for crisis management.[24] As a neutral and transparent basis of decision-making, this information is supposed to help politically responsible persons and protagonists in charge of civil protection to decide, on behalf of the citizens, about the handling of risks. These decisions relate to risk management (e. g. prioritisation of measures for the minimisation of risks), emergency planning (e. g. preparation for inevitable incidents) and crisis management (e. g. provision of resources).

The preparation and provision of risk analysis results for political decision-makers and the general public is an important component of risk management. While risk analysis itself is a rather sober, scientific process, risk evaluation and the resulting consideration and selection of risk mitigating measures is, to a considerable extent, influenced by political and social aspects. To this end, an appropriate dialogue has to take place between competent authorities, science, politics and the general public. In this context, not only the identified risks but also gaps in knowledge and uncertainties have to be communicated.

As a general rule, the evaluation of identified risks takes place in a dialogue between analysts and politically responsible persons by comparing the identified risks to the desired levels of protection (i. e. the definition to what extent and in what quality the subjects of protection should be protected or to what extent capabilities for crisis management should be provided).

Additionally, there will be a discussion needed between public authorities and citizens about risk analysis results and their evaluation. This is a dialogue on legitimating social negotiations (Evers 1993, p. 364). However, a discussion is only possible if respective results from science and authorities are public and understandable. It has, e. g., to be clearly stated which results are verified and reliable and which of them are still based on assumptions. Such a procedure shows that absolute security cannot be guaranteed by governmental institutions and that an adequate preparation of the citizens by themselves is required and promoted.

24 As to the role of the analyst as decision preparer, cf. Eppler & Mengis 2003.

Luhmann (2003, p. 166) declares in a sober way that the typical feature of risk situations is the fact that we do not know enough. The assumptions on which decisions and analyses are based can, of course, be questioned. And it is possible that they become outdated as time goes by. At the end of the day, the question is to decide to which extent of uncertainty the (majority of) society can live at the moment.

4

Prospects

The method of risk analysis described in this guideline can be implemented at all administrative levels. With manageable effort, good results can be quickly obtained. A factor of success is the inclusion of interdisciplinary expertise from various authorities, right from the start of the procedure, in order to cover as many aspects as possible of the variety of risks. At the same time, an intelligent integration of existing data can be achieved via interdisciplinary cooperation between authorities, in order to generate reliable findings.

If the results of the risk analyses from various administrative units are supposed to be compared at the same level or summarised at a superior level, the use of standardized scenarios, impact parameters and indicators for their operationalisation as well as consistentthreshold values for the classification of likelihood and impact is necessary. For risk analysis at the levels of federal states, rural districts and municipalities, an adequate joint definition by the future users of the method should be carried out. The parameters suggested by BBK can serve as a basis for a corresponding coordination processes. Generally, it is assumed that risk analysis results are more likely to be accepted if various departments/divisions/disciplines are involved in the definition of these values. Therefore, the cooperation of all players and administrative levels should be further intensified in order to concentrate and communicate the respective findings in an appropriate way.

The joint assessment of risks will lead to further questions at all levels. In order to answer these questions, specific research might be necessary. The results of respective research activities and above all the results of individual risk analyses will help to strengthen the protection of the population in Germany.

The wide practical application of the method for risk analysis will show whether the support of the analysis by information technology is reasonable.[25] The use of computer-based Geographical Information Systems (GIS) can, e. g., specifically complement the risk analysis process.[26] A GIS allows for complex spatial analyses and the creation of new information, which can be visualised by intuitively comprehensible maps. Thus, a GIS is the ideal tool for the execution of more detailed, spatial analyses of subjects of protection, hazards and risks. The results can be shown in tailored maps, which can be used for specific information and decision support in risk and crisis management. The use of GIS was already described in 2003 in the technical report "Creation of a protection data atlas". In many areas of risk prevention such applications have already become common practice, e. g., in the context of flood prevention or the calculation of distribution models related to the release of hazardous substances.

25 The Swiss Federal Office of Civil Protection, example.g., offers a cost-free programme for the support of risk management, called RiskPlan,: http://www2.vbs.admin.ch/internet/apps/riskmanagement/(05.03.2010).

26 With the help of standard GIS-software a large variety spatial data can be saved, updated, analysed and presented by maps.

5

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Appendix

Appendix 1
Glossary

The definitions listed here reflect the understanding of BBK in the context of risk analysis. These terms might have a different meaning in other contexts.

TERM	DEFINITION
Event	Spatial and temporal conjunction of subject of protection and hazard
Hazard	Condition, circumstance or process that can result in damage to a subject of protection
Risk	Measure for the likelihood of a particular damage to a subject of protection under consideration of the potential damage extent
Risk analysis	Systematic procedure to determine the likelihood of a certain damage to a subject of protection under consideration of the potential damage extent
Risk evaluation	Procedure to (1) ascertain to which extent a previously defined protection goal will be achieved in case of a certain event (2) decide which remaining risk is acceptable and (3) decide whether measures for mitigation can/have to be taken
Risk management	Continuously ongoing systematic procedure for the goal-oriented treatment of risks including analysis and evaluation of risks as well as planning and implementation of measures for risk mitigation/-minimization and risk acceptance
Damage	Negatively perceived consequence of an event to a subject of protection
Subject of protection	Anything that is to be protected from damage due to its ideal or material value
Protection aim	Aspired condition of protected property which has to be maintained when an incident happens
Scenario	Assumption of possible events or sequences of events and their effects on subjects of protection
Vulnerability	Measure for a subject of protection's assumable susceptibility to damage with regard to a particular event

Appendix 2
Index number catalogue of the Joint Hazard Estimation

Index number	Title/description
3100	**Hazards and requirements due to natural events and anthropogenic environmental influences**
3110	**Extreme weather conditions**
3111	Storm/hurricane/tornado
3112	Intense rainfall, hail, freezing rain, black ice
3113	Long-lasting snowfall/snow banks
3114	Long-lasting strong frost
3115	Avalanches
3116	Strong thunderstorms with massive lightning strikes
3117	Heat and drought periods with bad harvests and/or shortage of drinking water
3118	SMOG
3120	**Earthquakes**
3130	**Earthmoving**
3131	Subsidence/land subsidence/landslides
3140	**Large-scale fires (forest fire, heath fire, moor fire)**
3150	**Floods/storm floods**
3151	Floods caused by dam bursts
3152	Local floods caused by heavy rainfall
3153	High water in brooks, rivers and river valleys
3154	Storm floods/floods on sea coasts and inland lakes
3160	**Impact of meteorites**

Index number	Title/description
3200	**Hazards and requirements due to NBC situations, technology and transportation accidents and large-scale fires**
3210	**A-hazards**
3211	Release of hazardous substances from national nuclear power plants
3212	Release of hazardous substances from nuclear power plants of neighbour countries
3213	Release of hazardous substances from nuclear power plants of other countries
3214	Release of hazardous substances from other nuclear plants (research reactors, reprocessing plants or other plants with radioactive substances)
3215	Release of other radioactive substances
3220	**B-hazards**
3221	Epidemics (e. g., influenza and pandemics)
3222	Animal diseases (epizootics)
3223	Large-scale plant diseases
3224	Release of pathogenic substances or micro organisms from biological/ gene-modified plants
3225	Release of other pathogenic (biological) substances or micro organisms
3230	**C-hazards**
3231	Release of toxic substances (excluding Seveso plants)
3235	**Release of hazardous substances from stationary objects with known hazard potential (Seveso plants, e. g. release of certain nonhazardous substances which burn, explode, deflagrate or become pathogenic or toxic due to the compound with other substances only by their release)**
3240	**Release of hazardous substances during transportation accidents (road, railway, water ways, including coastal waters and open sea, air)** Information about pipelines either under this index number or under 3260
3241	Road, railway, air
3242	Inland waterways
3243	Coastal waters/open sea

Index number	Title/description
3245	**Large-scale fires, explosions, bursting, deflagration**
3250	**Large number of affected people**
3251	Road, including crossings and tunnels
3252	Railway, including crossings and tunnels
3253	Waterways, including coastal waters and open sea as well as inland lakes
3254	Air
3255	Large number of affected people due to other reasons
3260	**Serious disruption and damage in facilities for supply and food (critical infrastructure – supply)** Information about pipelines either under this index number or under 3240
3261	Water
3262	Food
3263	Gas (natural gas, liquid gas)
3264	Electricity
3265	District heat
3266	Mineral oil
3267	Coal
3269	Health (hospitals/clinics, central storage facilities for drugs, …)
3270	**Serious disruption and damage in facilities for disposal (critical infrastructure – disposal)**
3271	Wastewater system, sewage works
3272	General waste disposal, landfills, destructors
3273	Special waste destructors
3280	**Long-lasting disruption/large-scale breakdown of the information, communication and warning systems under consideration of interdependences and domino effects (critical infrastructure – information technology)**

Index number	Title/description
3281	Telephone networks, radio networks, IT networks
3282	Satellite-based systems
3283	Radio and television
3290	**Impact of cosmic missiles**
3295	**Hazard caused by warfare materials abandoned sites**
3300	**Hazards and requirements due to terrorism/attacks/ assassinations/sabotage**
3400	**Acts of war on or above German territory or in border areas of neighbour states to Germany**

List of abbreviations

BABS	Federal Office of Civil Protection FOCP (Switzerland)
LAWA	German Working Group on water issues of the Federal States and the Federal Government
SEMA	Swedish Emergency Management Agency
GIS	Geographical Information System
DHS	Department of Homeland Security (USA)
GAO	United States Government Accountability Office
ETH	Swiss Federal Institute of Technology Zürich
IPSC	Institute for the Protection and Security of the Citizen
JRC	Joint Research Centre der EU-Kommission
BNatSchG	The Federal Nature Protection Act in Germany
DEMA	Danish Emergency Management Agency
DVWK	German Association for Water Management, Water Building and Landscape Ecology
BImSchV	German Federal Immission Control Ordinance
EM-DAT	Emergency Events Database
CRED	WHO Collaborating Centre for Research on the Epidemiology of Disasters

Notes

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