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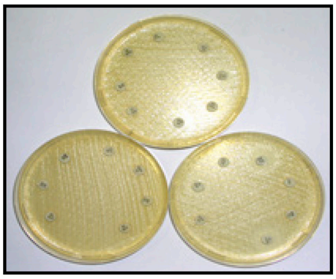
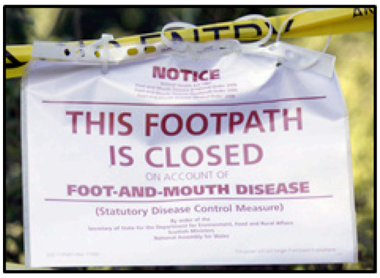
Swiss Expert Committee for Biosafety SECB

Biological Risks in Switzerland

Evaluation, Comparison and Prioritisation
November 2019





Swiss Expert Committee for Biosafety (SECB),
c/o Federal Office for the Environment BAFU, 3003 Bern
Tel. +41 58 46 303 55
info@efbs.admin.ch
www.efbs.admin.ch

Project Team

SECB (Legislative Period 2016-2019)
Reinhard Zbinden (President)
Patricia Ahl Goy
Eric Dumermuth
Tim Haye
Urs Klemm
Brigitte Mauch-Mani
Monika Maurhofer
Matthias Meier
Paola Pilo
Daniel Rigling
Nicola Schoenenberger
Jacques Schrenzel
Katharina Stärk
Volker Thiel
Mauro Tonolla

Former SECB-members (Legislative Period 2012-2015)
Pascal Meylan (Former President)
Joachim Frey
Felix Gmünder

SECB-Executive Office
Isabel Hunger-Glaser (Executive Manager)
Julia Link

With the support of

Ernst, Basler & Partner, EBP
Christine Steinlin
Lilian Blaser
Tillmann Schulze

FOCP (KNS-Study)
Markus Hohl

Foreword

For years we have been dealing with biological hazards. In doing so, we find that some of them are very diverse and are not always perceived according to their real risk. With an objective approach to assessment, we want to help ensure that precautionary measures are adequately prioritised.

The present study considers developments with a ten-year horizon. The seven selected examples reflect the range of work of the SECB. The risk analysis is based on scenarios of varying likelihood of occurrence and complements the risk analysis of disasters and emergencies for Switzerland (KNS) from the Federal Office for Civil Protection (FOCP).

By prioritising the risks, we want to help the participants involved to address and communicate the issues identified according to their importance.

To act with foresight pays off. Precautions should be taken when possible to avoid situations arising. For instance, a person who is seriously sick in hospital, suffering from a bacterial infection can no longer be treated with antibiotics, or pork production breaks down because of swine fever. Likewise, our vineyards in Lavaux, a UNESCO World Heritage Site, must not be infected and destroyed by dangerous plant diseases (such as *Xylella fastidiosa*), resulting in no more wine being produced.

If we all take the right measures at the right time, we can continue to ensure the safety of humans, animals and the environment in the future and live in a healthy, prosperous Switzerland.

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1. Introduction

1.1 Starting position

The Swiss Expert Committee for Biosafety (SECB) is a permanent federal committee which advises the Federal Council and the federal offices on the preparation of laws and ordinances, on enforcement, and on applications for authorisation. In doing so, the SECB deals intensively with threats that concern current issues of biosafety in Switzerland. As part of the project "Comparison and Prioritisation of Biological Risks", the SECB analysed seven possible threats to Switzerland and assessed their risks. The firm EBP assisted the SECB in analysing the risks. This report summarises the results of the project "Comparison and Prioritisation of Biological Risks".

The study is to be considered as a supplement to the national risk analysis «The National Risk analysis of Disasters and Emergencies in Switzerland (KNS)»[1]. Certain biosafety threats have not been addressed within the remit of the work of the SECB (e.g. pandemics) or only partially (e.g. epidemics) as they are already part of the KNS study. However, it must be noted that the results of the present risk analyses are only conditionally comparable with the results of KNS, since the methodological approach to risk assessment is similar, but not identical.

In contrast to the KNS study, which is based on possible events at a certain point in time, the seven threats considered by the SECB include not only incidents, but also developments or trends and were estimated for the next ten years. The focus was on realistic appearing threats and not worst-case scenarios, which are used in the accident analysis. Threats that could result from the misuse of organisms (bioterrorism, dual use) were explicitly excluded.

1.2 Objectives of project

The Project “Comparison and Prioritisation of Biological Risks” serves to achieve the following goals:

- Describe current biological threats with potential significant to extreme impact for Switzerland and related scenarios.
- Assess the risks (extent and probability of occurrence) of these biological hazards.
- Compare the risks of these biological threats with each other in order to lay the groundwork for a subsequent prioritisation of the precautionary measures against the hazards.
- Establish a basis to objectify the perception of these biological hazards for the public and quantify the risk of these threats with each other.

1 Disasters and emergencies in Switzerland (KNS); Federal Office for Civil Protection (FOCP); https://www.babs.admin.ch/de/aufgabenbabs/gefaehrdrisiken/natgefaehrdanalyse.html

2. Procedure

2.1 Process

The SECB as a first step described the hazards and their definitions, known incidents, actual developments, influencing factors and possible scenarios in hazard dossiers (Figure 1). In the second step, the SECB carried out a risk analysis and estimated the risks of the scenarios. In the third step, the risks from the seven analysed hazards were compared in a risk matrix, in order to prioritise them. Therefore, in the future, limited resources would be used based on established criteria.

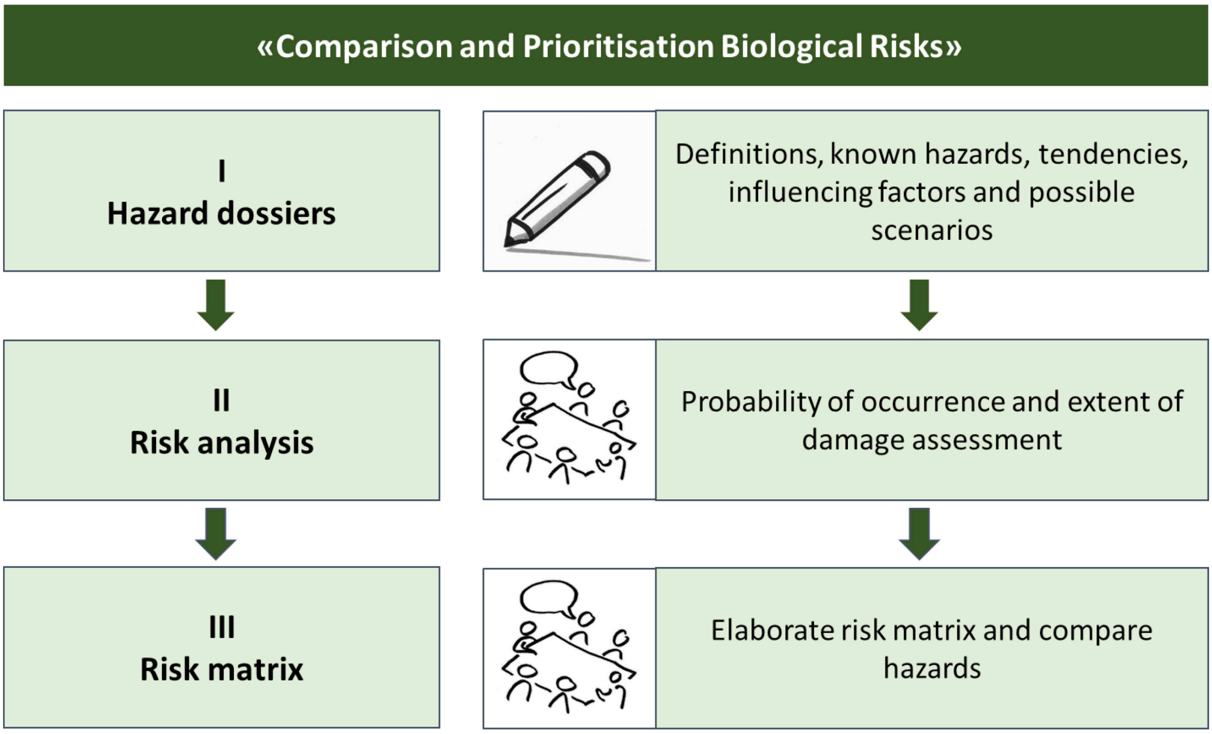

Figure 1 Project Process

2.2 Step I: Creation of hazard dossiers

In the first step, the members of the SECB created a hazard dossier for each analysed risk. The dossiers are uniformly structured and include the following content:

1. Introduction and definition
2. Known events and developments
3. Relevant influencing factors
4. Risk analysis including hazard scenarios, possibility of occurrence and extent of damage

For every hazard, the authors developed, where possible, intensity levels of potential reference scenarios, *significant*, *major* or *extreme*. The intensities are defined according to the national risk analysis of the Federal Office for Civil Protection (Disasters and Emergencies for Switzerland, KNS)[2] as follows:

— significant: scenario that is considerably more severe than an everyday event.

— major: scenario of great intensity. Nevertheless, considerably more severe occurrences and courses of events are imaginable in Switzerland.

— extreme: scenario of extreme intensity. Such occurrences are only just imaginable in Switzerland, but are highly improbable.

2.3 Step II: Likelihood assessment of occurrence and extent of damage

In the context of two workshops, the SECB members discussed the hazard scenarios as well as the likelihood of occurrence and the extent of damage, as well as comparing the scenarios with each other. The assessments were based on the methods of the national risk analysis of the Federal Office for Civil Protection (Disasters and Emergencies for Switzerland, KNS).[2]

To assess the likelihood of occurrence of the SECB scenarios, the KNS method was simplified. The likelihood of occurrence of the hazard scenarios were divided into four classes from very likely to very unlikely and the time period restricted to the coming ten years (Table 1). The reason for this simplification was that the hazards used in the described studies were in part developing. In contrast to existing recurring hazards, no statistical information is available for these hazards. The likelihood of occurrence was therefore based on the current and developing situation here and abroad.

Table 1 Probability Classes

SECB-Class	Description
SECB 4	The situation described in the scenario / the occurrence of the described event in the next ten years is ***very likely***.
SECB 3	The situation described in the scenario / the occurrence of the described event in the next ten years is ***likely***.
SECB 2	The situation described in the scenario / the occurrence of the described event in the next ten years is ***unlikely***.
SECB 1	The situation described in the scenario / the occurrence of the described event in the next ten years is ***very unlikely***.

The extent of damage was also assessed by the SECB using the KNS method. For every scenario, the effects were estimated using 12 indicators (Table 2). For each indicator, the extent of damage was defined from Class A1 to A8 (Appendix 1). The indicators “public order and domestic security” as well as “territorial integrity” were not relevant to the biological hazards analysed in any scenario.

2 A method for risk analysis of disasters and emergencies in Switzerland (KNS); Federal Office of Civil Protection (FCOP); Version 1.03; Bern, 2013.

Table 2 Indicators according to KNS; the italicised indicators were not relevant for any of the hazards evaluated by the SECB.

Damage Area	Indicator	Unit
Individuals	Fatalities	Number
	Casualties/sick	Number
	Support needed	Person days
Environment	Damaged area and duration	km^2 x year
Economy	Property damage and management costs	CHF
	Reduction of economic efficiency	CHF
Society	Supply interruptions	Person days
	Diminished public order and domestic security	*Person days*
	Damaged reputations	Intensity x duration
	Loss of confidence in state/institutions	Intensity x duration
	Restriction of territorial integrity	*Intensity*
	Damage and loss of cultural assets	Number x importance category

2.4 Step III: Creation of risk matrix

For the representation of the extent of damage in the risk matrix, the 10 indicators were monetised and added together. To enable this, the values of the indicators were converted to monetary damage by means of marginal costs. The marginal costs, based on the KNS study, are listed in Appendix 1.

3. Hazards and risk analysis

This chapter summarises the most important content of the hazard dossiers for the seven biological hazards identified by the SECB. It describes definitions, examples of events, relevant influencing factors, hazard scenarios as well as the result of the risk analysis.[3]

For the aid of readability, the different damage areas are depicted in colour: the damaged area with respect to individuals in yellow, for the environment in green, the economy in blue and society in red (Figure 2 to Figure 9).

3 Each full hazard dossier is available on request from the SECB: info@efbs.admin.ch

3.1 Invasive plant pathogens using *Xylella fastidiosa* as an example

Introduction

The international trade in goods unintentionally carries invasive non-resident pests worldwide; These can cause huge economic and ecological damage to cultivated or wild plants. *Xylella fastidiosa* is a bacterial plant pathogen that is currently spreading in Southern Europe. The bacteria can infect a variety of plants and can be spread by trade of the host plants. Insect vectors also play an important role in the local spread of the bacteria. Grapevines are particularly threatened by *X. fastidiosa*, in which a subspecies of the bacteria causes Pierce's disease. This disease has been causing major problems in the wine regions of the USA and South America for a considerable time. Notably, dangerous harmful organisms such as *X. fastidiosa* are defined throughout Europe as a quarantine organism.

Examples of incidents

— Since 2008, Switzerland
The fungus *Hymenoscyphus fraxineus* has been attacking Ash trees. The disease first appeared in 2008 in Switzerland. In the worst case, the infection leads to the death of the tree.

— Since 1989, Switzerland
The bacterium *Erwinia amylovora* causes the plant disease Fire Blight. The disease mainly affects apple and pear production in commercial orchards.

— Since the mid-19th century, Europe
Potato or Late Blight (*Phytophthora infestans*) affects potatoes and tomatoes. It has been occurring since the 19th century and has been controlled by the heavy use of fungicides. However, the development of resistance could become a problem in the future.

Relevant influencing factors

— Import quantity and frequency of host plants from infected areas

— Dissemination of *X. fastidiosa* in Europe

— Presence of suitable host plants and insect vectors

— Presence of asymptomatic host plants (hidden reservoirs, primarily trees)

— Temperature – warmer regions are more prone to infection with *X. fastidiosa*

— Availability of studies on potential host plants

— Preventative measures such as phytosanitary control of imported plants and monitoring of areas

— Emergency planning and measures in case of an outbreak of disease

Hazard scenarios

Significant: Individual plants or plant groups in a vineyard are infected with *X. fastidiosa*. Further plants are then infected and the affected plants die. The implementation of strict measures leads to a successful control of the infection.

Major: Several vineyards in a larger wine-growing area of Switzerland (e.g. Ticino, Geneva, Vauds, Valais) are infected with *X. fastidiosa*. Due to the rapid spread of the pathogen, the entire region is affected after some time. In several vineyards, a substantial stock of plants will die. The damage to Switzerland is great, not just for the vineyards themselves, but for tourism in the wine region. The wineries lose their value as a cultural asset through the loss of plants.

Extreme: Throughout Switzerland, all vineyards are infected with *X. fastidiosa*. The high infection as well as the high rate of mortality leads to the loss of essential grapevine stocks. Switzerland suffers damage to its reputation as a wine producer as well as consequences for tourism. In addition, important cultural assets would be lost as a result of the damage to its vineyards. The confidence in the state/institutions would be damage.

Risk analysis

The occurrence of the *significant* scenario is considered to be *highly likely* in the next ten years and the likelihood of the *major* scenario *likely*. Both scenarios assume that *X. fastidiosa* will be introduced in the next ten years into Switzerland. The pathogen is already present in other European countries and has been discovered in imported plants. Several other plant pathogens (e.g. *E. amylovora*) have in the past also reached Switzerland after being first reported in other European lands. Even when Pierce's disease would spread rapidly in Switzerland, the *extreme* scenario is considered *unlikely* as the disease has been present for many years in California without a significant decline in wine production. However, the disease causes considerable coping costs.

The spread of the invasive plant pathogen *X. fastidiosa* does not cause any damage on individuals. An exception however may be wine growers who may need temporary mental support in the *extreme* situation. The environmental damage may also affect wild plants, since due to climate change *X. fastidiosa* could become able to additionally infect some of these wild plants. The financial losses and coping costs arise through the monetary loss of the wineries as well as through control measures and necessary replanting. Indirect costs include the loss in wine production. In many regions, the vineyards serve as a recreational area and thus have a cultural and tourist value that is reduced by the loss of the vineyards. Confidence in the state/institutions would also decrease.

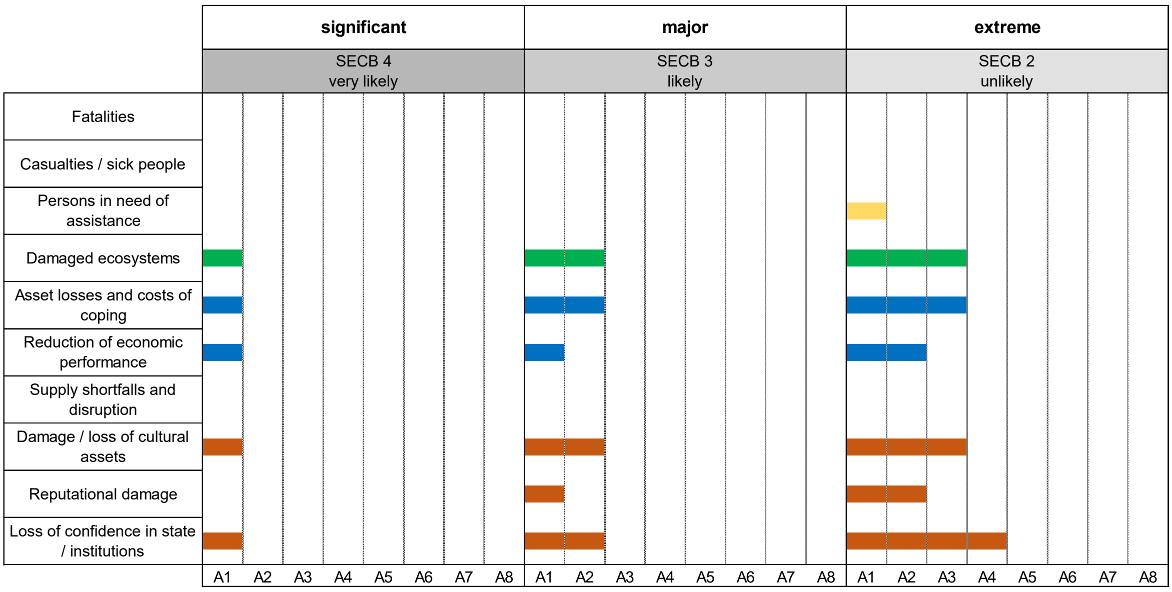

Figure 2 Assessment of the threat of "Invasive plant pathogen using the example of *Xylella fastidiosa*"

3.2 Animal epidemics

Introduction

An animal epidemic is a viral- or bacterial-related disease that affects animals and can spread rapidly because of their infectious properties. Prevention and measures for epizootic diseases are regulated by the Animal Health Act[4] and the Animal Health Ordinance[5]. According to the Animal Health Act, epizootic diseases are transmissible animal diseases which can be transmitted to humans (zoonoses), which can't be combated by individual livestock farmers, can threaten native wild species, can have significant economic consequences or are important for international trade in animals and animal products.

Examples of incidents

— 2016–2017, Switzerland/Europe
Outbreak of highly pathogenic avian influenza in Europe. In Switzerland over 100 wild birds tested positive. In contrast to the EU, poultry was not affected in Switzerland.

— 1993/1998, Switzerland
In 1993 there were five outbreaks of classical swine fever in pig farms, which could be brought under control quickly. Despite numerous epidemics in the rest of Europe in the following years, Swiss pig stocks were spared. In 1998, classical swine fever occurred in wild boars in Ticino. The collaboration between veterinarians, gamekeepers, hunters and scientists prevented the spread to domestic pigs.

Relevant influencing factors

— Introduction of the hazard (pathogen and susceptible species)

— Propagation of vector habitats, frequency of vectors

— Uncontrolled movement/migration of wild animals

— Import of animals and animal products through travel

— Safety of feed

— Genetic changes in the infectious agents (pathogenicity, cross-species transmission pathways)

— Biosafety measures in establishments

— Effectiveness of vaccinations (if available)

Hazard scenarios

Significant: After the occurrence of the first cases in neighbouring countries, African swine fever[6] occurs in some regions of Switzerland. Contagiousness and mortality rate are low and the disease is demonstrated to not be zoonotic. There is a reputational damage for Switzerland and the population loses confidence in the state.

Major: Following the first occurrence in neighbouring countries, Foot-and-mouth disease occurs in multiple regions of Switzerland, leading to a high infection and lethality in animals. Transfer to humans is rare and without major consequences. The reputational damage for Switzerland and the loss of confidence in the state are considerable.

Extreme: Across Switzerland, a new disease, similar to the Schmallenberg virus or zoonotic influenza, spreads with potential zoonotic effects. The transmission from animal to animal as

4 Animal Health Act, https://www.admin.ch/opc/de/classified-compilation/19660145/index.html (in German)

5 Animal Health Ordinance, https://www.admin.ch/opc/de/classified-compilation/19950206/index.html (in German)

6 As an alternative scenario with similar risk, Lumpy-skin disease would be conceivable.

well as the lethality are very high. The disease is also transmitted to humans. The reputational damage for Switzerland and the loss of confidence in the state are enormous.

Risk analysis

The *major* and *extreme* intensity scenarios were not subject to the SECB analysis, as these are part of the risk analysis for “Animal Epidemics” from the KNS. In this document, the risk of the scenarios was analysed in detail. For these scenarios the KNS hazard dossier “Animal Epidemics” should be consulted.[7] A direct comparison with the KNS study is not possible, therefore this scenario will not be described here.

The *significant* scenario is considered *likely* as cases have been seen in other European countries. There are currently no cases in Switzerland; however, the possibility exists that the disease could be transmitted to animals in Switzerland.

The *significant* scenario will not lead to deaths in humans, but may cause sickness and require affected individuals to need support. This is a result of psychological stress caused by the control measures against the animal epidemic (slaughter). Environmental damage is likely in the case of African swine fever caused by the infection of wild animals. Animal disease leads to financial losses and coping costs primarily on the affected farms. The economic performance of the affected farms as well as the export sector will be negatively affected. Since an animal disease usually occurs in several countries, the damage to the reputation of Switzerland is likely to be limited, but there would be a loss of confidence in the state/institutions by the general population.

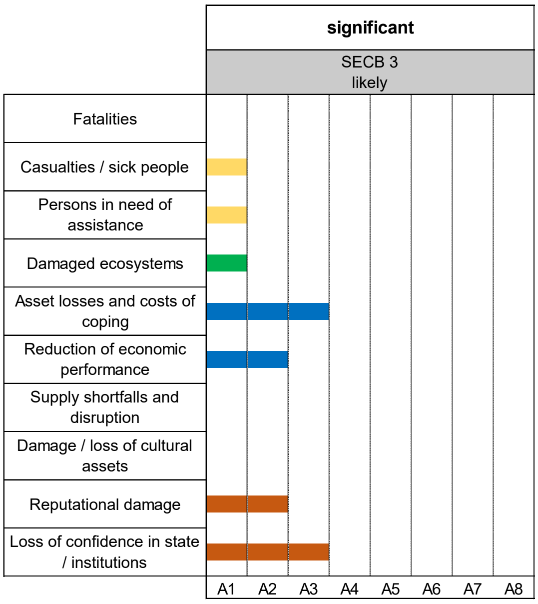

Figure 3 Assessment of the threat “Animal epidemics”

7 KNS-hazard dossier “Animal Epidemics”, 30th June 2015: https://www.babs.admin.ch/content/babs-internet/de/aufgabenbabs/gefaehrdrisiken/natgefaehrdanalyse/gefaehrddossier/_jcr_content/contentPar/accordion/accordionItems/gesellschaftsbedingt/accordionPar/downloadlist/downloadItems/525_1461741014686.download/gd_tierseuche_de.pdf

3.3 Diseases transmitted by invasive vectors: Tiger mosquito (*Aedes albopictus*) causing Chikungunya epidemics in Switzerland

Introduction

The tiger mosquito (*Aedes albopictus*) is a threat to human health because it can transmit pathogens to humans. The transmissible diseases include Dengue, Chikungunya and Zika viruses. The tiger mosquito is an aggressive, diurnal mosquito. Currently, tiger mosquito occurrences are reported in 27 European countries. In Switzerland, the tiger mosquito has initially established itself in the cantons of Ticino, Grisons and Basel, and it has been occasionally observed in other cantons.

Examples of incidents

- 2017, Italy
  An outbreak of autochthonous Chikungunya in Lazio and Calabria. A total of 489 reported cases, 6% of them hospitalised.
- 2010, France
  Two cases of Dengue Fever in south east France, where the tiger mosquitoes are common. Both patients were infected in France, not abroad, and were hospitalised.
- 2007, Italy
  An outbreak of Chikungunya in the province of Ravenna. The pathogen was probably imported by a returning traveller from India. A total of 334 cases were reported within a radius of 49 km, with one fatality. The transmission of the virus through tiger mosquitoes demonstrates their efficiency as a transfer vector.
- 1927–1928, Greece
  The last high-lethality rate dengue epidemic in continental Europa transmitted by the Egyptian tiger mosquito, *Aedes aegypti*.

Relevant influencing factors

- Climate change leads to suitable climatic conditions throughout Switzerland, with the exception of the Alps. The Urban Heat Island effect means that cities are suitable for the propagation and hibernation of insects.
- The mobility of individuals and goods as well as urban centres with dense populations lead to easier carry-over and spreading of vectors and the disease.
- Measurements for mosquito monitoring
- Awareness of doctors and workers in laboratories
- Awareness of the population as well as prevention
- Epidemiological and entomological surveillance (early detection) and rapid reaction

Hazard scenarios

Significant: In Switzerland, there is a Chikungunya epidemic with 100 individuals affected. Eight individuals are hospitalised, but no deaths. Coping costs for mosquito-control measures, economic damage, supply bottlenecks for blood products, reputational damage to Switzerland and the loss of confidence in the state are considerable.

Major: In Switzerland, there is a Chikungunya epidemic with 1'000 affected individuals. Eighty-four individuals are hospitalised, and there is a single death. Coping costs for mosquito-control measures, economic damage, supply bottlenecks for blood products, reputational damage for Switzerland and the loss of confidence in the state are high.

Extreme: In Switzerland, there is a Chikungunya epidemic with 10,000 individuals affected. 1'000 individuals suffer a coinfection with Dengue. 950 individuals are hospitalised, with 15 deaths. Coping costs for measures to control mosquitoes, the economic damage, the supply bottlenecks in blood products, the reputational damage for Switzerland and the loss of confidence in the state are huge.

Risk analysis

The *significant* scenario is considered to be *likely* in the next ten years as the tiger mosquito is already present in parts of Switzerland and autochthonous transfers of chikungunya in Europe have been confirmed. The scenarios *major* and *extreme* are classified as *unlikely* and *very unlikely*, as a large number of individuals would need to be affected.

The damage on individuals relates to the number of affected persons described in the scenarios. The intensive mosquito control damages ecosystems, which leads to a biodiversity loss. The coping costs include the costs of mosquito control and health care. Economic efficiency will be limited by sick individuals. The supply bottlenecks in blood products arise because of preventive measures in the blood donation system.[8] The epidemic damages Switzerland's reputation abroad and public confidence in the state/institutions will decrease.

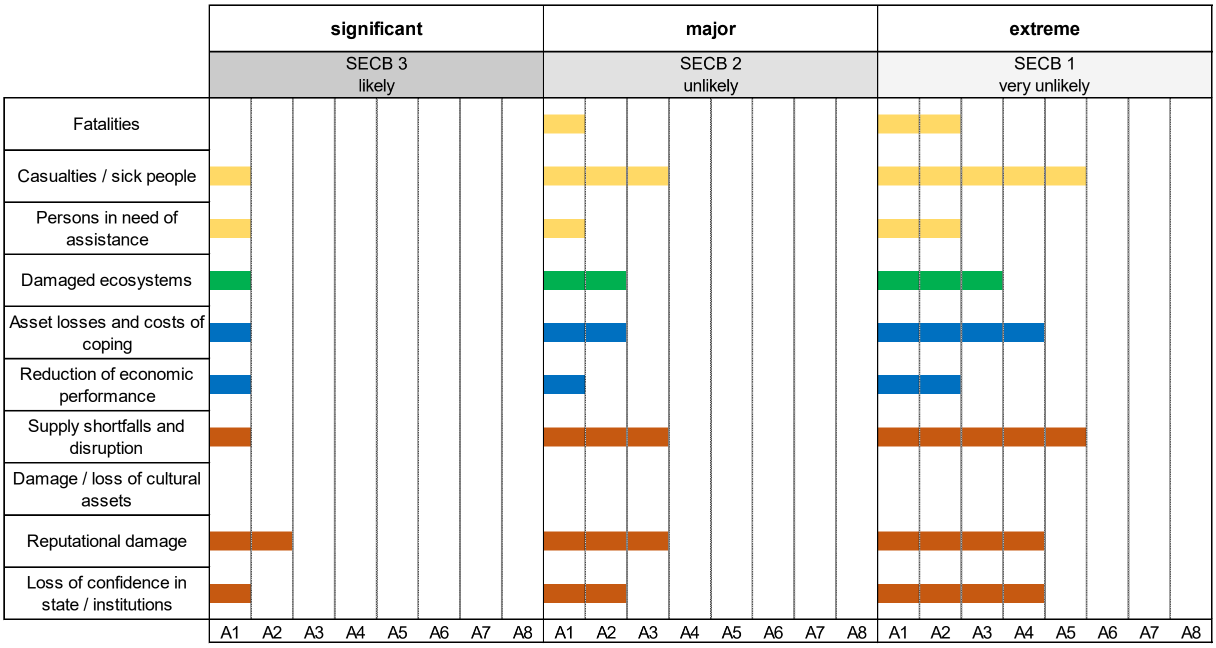

Figure 4 Assessment of the threat “Diseases transmitted by invasive vectors using the tiger mosquito (*A. albopictus*) as an example for Chikungunya epidemic”

8 E.g. Restrictions on blood donations due to the epidemic

3.4 Antibiotic resistance

Introduction

Antibiotic resistance means the resistance of bacteria to antibiotics. Antibiotic resistance increases the likelihood of complications and death after a bacterial infection. In Europe, about 25,000 patients die every year due to antibiotic resistance. Antibiotic resistance is also occurring in Switzerland; the number of deaths is estimated to be around 200 patients per year.

The currently available reserve antibiotics are already being used more frequently because resistance has increased significantly in the last 20 years. The further spread of antimicrobial resistance may become more serious in the future because reserve antibiotics with more side effects need to be used to treat hospital-acquired bacterial infections (nosocomial infections). The situation becomes catastrophic when bacteria also become resistant to these reserve antibiotics.

Examples of incidents

— Currently, India, China and Russia
  In 2016, there were 600,000 tuberculosis cases worldwide with bacteria resistant to the normally most effective tuberculostatic (antibiotic against tuberculosis). 490,000 cases were even resistant to several antibiotics. Half of these cases occurred in India, China and Russia.

— Currently, G20 countries
  The incidence of antibiotic resistance in eight common bacteria in the G20 countries has increased from 18% in 2000 to 22% in 2014. If antibiotic consumption continues to increase, an incidence of 28% is expected by 2030.

— Currently, Switzerland
  At present, 15% of all *Escherichia coli* isolated from patients with sepsis in a Swiss university hospital have a particularly high level of resistance.

Relevant influencing factors

— Amount and type of antibiotic used in humans, animals and agriculture and their monitoring

— Commitment of governments, health systems, the pharmaceutical industry, agriculture and the food industry against the further spread of antimicrobial resistance

— Global awareness of patients, physicians, pet owners and veterinarians on the issue of antibiotic resistance

— Globalisation, travel and migration

— Development of new antibiotics and their commercial appeal

— Hygiene in all areas of life (including food hygiene), as fewer infections reduce the use of antibiotics

Hazard scenarios

The hazard scenarios and the risk analysis are based on the assumption that the Swiss strategy for antimicrobial resistance (StAR) will be implemented as planned. The hazard scenarios are realistic despite the successful implementation of StAR.

Significant: The number of complications in nosocomial infections and subsequent fatalities due to false empirical therapy against the resistant bacteria as well as the risk from treatment with reserve antibiotics exhibiting higher side effects and interventions due to initially unsuccessful antibiotic therapy would increase slightly in this scenario. Significant costs are incurred through prevention, hygiene, analysis and quarantine measures.

Major: The number of complications and deaths as well as the risk of therapies and interventions would slowly but steadily increase in this scenario. There are increased costs through prevention, hygiene, analytics and quarantine measures. The costs of treatments and stock-breeding become higher. There would be an increasing loss of life and livestock. In some areas, a reduction in economic performance with supply interruptions would become evident; the loss of trust in public institutions as well as the damage to Switzerland's image would become a national theme.

Extreme: In this scenario, the number of complications and deaths would increase markedly in the next few years by a factor of five. Antibiotics would no longer be effective. Numerous operations and therapies would become no longer possible. There would be uncontrollable epidemics and high losses of livestock. A reduction in economic performance would be associated with supply disruptions. The loss of confidence in public institutions as well as Switzerland's damaged reputation would become internationally noticeable.

Risk analysis

The *significant* and *major* scenarios are considered *very likely* and *likely* to occur as antibiotic resistance is already present in Switzerland and can have serious consequences. The *extreme* scenario is considered *very unlikely*.

The damage on individuals corresponds to the number of affected persons described in the scenarios. Ecosystems would not be affected by the hazard. Property damage and coping costs include healthcare costs, prevention, hygiene, etc. Bottlenecks in care would be caused by antibiotics being used as an important remedy. The reputation of Switzerland and the confidence of the population in the state/institutions would be damaged.

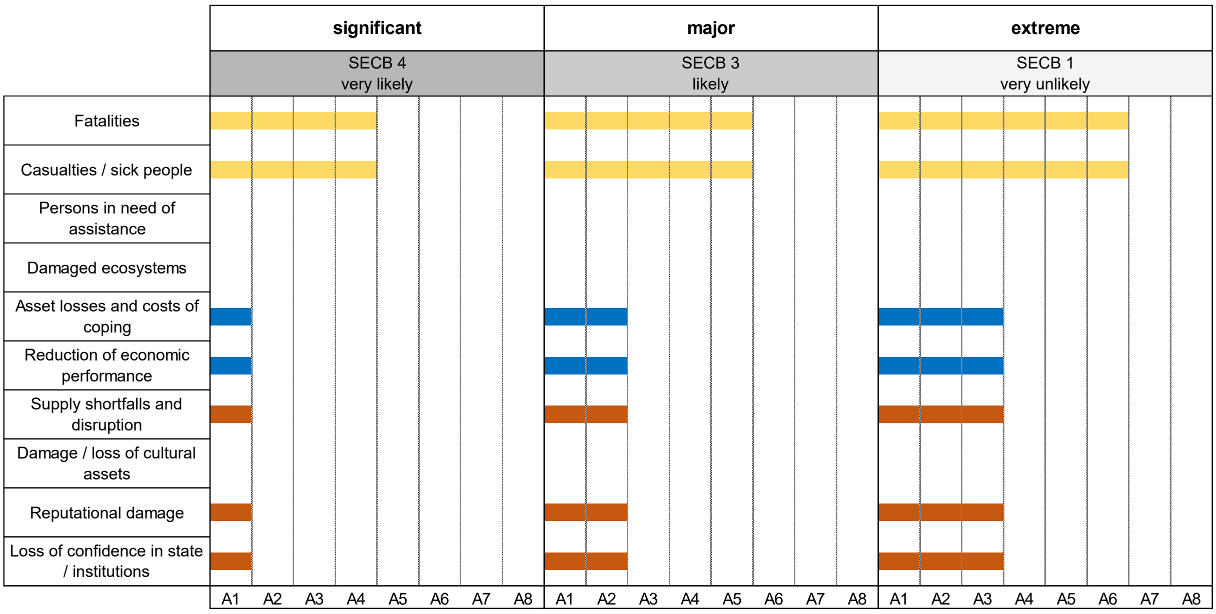

Figure 5 Assessment of the threat “Antibiotic resistance”

3.5 Food-associated infections

Introduction

Food-associated infections and toxin damage can result from microbial contamination of food (bacteria, viruses, fungi, and parasites) or bacterial or fungal toxins. The latter toxins (e.g. aflatoxin) are under control due to monitoring and hygiene measures, therefore they will not be dealt with here. Food-related infections are caused by violations of food safety regulations and lead to health problems in humans.

Examples of incidents

— 2017, France
  A French dairy enterprise had to recall over 7,000 tonnes of baby milk products after 20 babies contracted salmonellosis with some suffering from bloody diarrhoea.

— 2011, Germany
  In the summer of 2011, there was a build-up of sickness in connection with an enterohaemorrhagic *Escherichia coli* infection. In total, around 4,000 individuals fell sick and 53 died. The cause of the outbreak were fenugreek seeds imported from Egypt for seedling production. The recall of affected batches and import bans led to a curbing of the epidemic.

— 1984, Great Britain
  In 1984, the deadly BSE infectious disease ("mad cow disease") first appeared in cattle in the UK. In 1992, the highest level was reached with more than 37,000 cases. The subsequent new variant of Creutzfeldt-Jakob disease in humans was linked to the consumption of food from BSE-contaminated animals. 200 individuals worldwide became sick (173 in the UK), with 168 dying. As a result, the contamination of food by bovine risk material was stopped by implementing additional hygiene measures. The infection chain in the veterinary field was interrupted by a general feed ban on meat and bone meal.

— 1980, Canton of Basel
  During an orienteering event, a drink prepared with raw milk was distributed. As a result, 500 participants fell sick with campylobacter enteritis.

— 1963, Zermatt
  Drinking water contamination led to a severe typhoid epidemic in which 437 individuals were hospitalised and three individuals died. To handle the crisis, the B-service of the army was deployed. As a result of the epidemic, cantonal drinking water controls were tightened and the cantonal and federal authorities broadened expertise in the area of microbiological food hygiene.

Relevant influencing factors

— Availability of high quality and safe food, e.g. dependent on the infrastructure for production and distribution of food or environmental factors such as temperature

— Food legislation and enforcement (early detection, crisis management and risk communication, including mandatory reporting, epidemiological monitoring methods, operational risk analysis, etc.)

— Awareness of the topic of food hygiene in society

— Providing scientific foundation and epidemiological data

Hazard scenarios

Significant: At an open-air festival, food contaminated with salmonella, campylobacter or similar pathogens is given to a large number of visitors. After detection of the contamination, the sale of the food stopped and any distributed food recalled. The incident leads to sicknesses, costs for the recall campaigns, image loss and a few deaths.

Major: In a large city or agglomeration, drinking water is contaminated with pathogenic organisms (e.g. causing agents of typhus, cholera, etc.) (by technical failure or natural events). The failure of treatment and monitoring measures leads to the distribution of contaminated drinking water to a large number of residents. The consequences are sicknesses, deaths, economic losses, disinfection and cleaning costs, as well as a loss of confidence in the drinking water supply by the population.

Extreme: The proliferation of prions or similar pathogens with a long incubation period leads to a food-associated infection in the population. Due to lack of knowledge concerning transmission path and vector propagation, the outbreak persists. Lack of treatment options for affected patients leads to prolonged disease duration and numerous deaths.

Risk analysis

The *significant* scenario is considered to be *highly likely* to occur in the next ten years, as such contamination can happen relatively simply. The *major* and *extreme* scenarios are respectively classified as *unlikely* and *very unlikely*, as in Switzerland similar types of events happened some time ago, and only singular incidents have been reported worldwide.

The damage on individuals corresponds to the infected persons and the resulting deaths. The hazard does not affect ecosystems. Property damage and coping costs include costs for recall campaigns, cleaning costs and economic losses due to sick individuals. Supply bottlenecks may arise for certain products. In addition, *major* or *extreme* events lead to a damaged image of Switzerland abroad and a loss of confidence in the state/institutions.

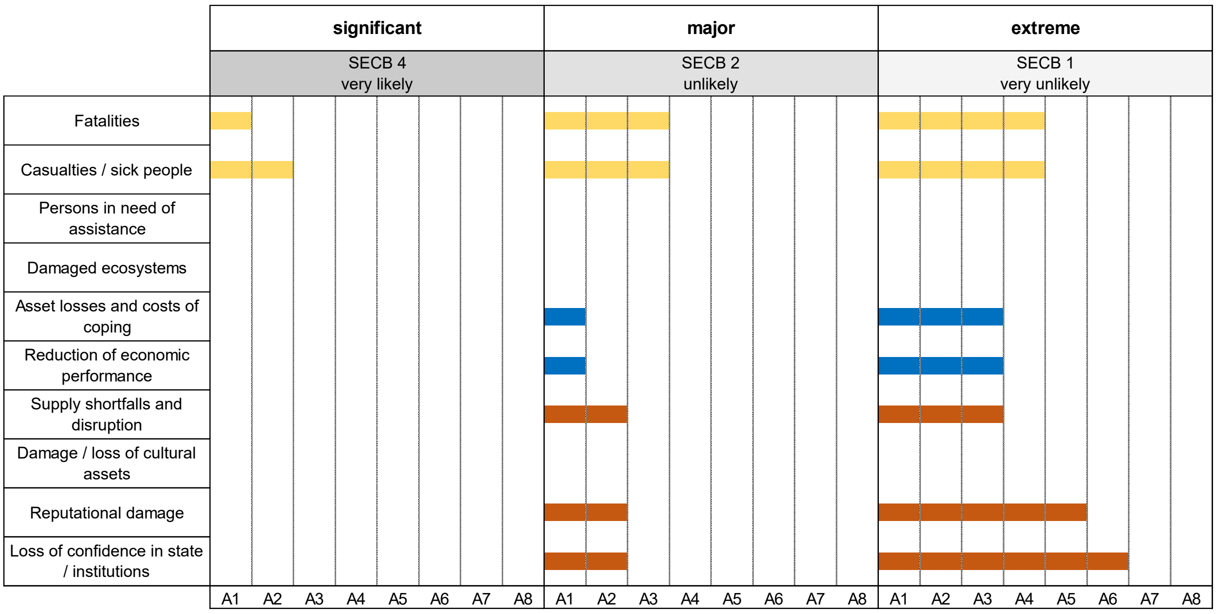

Figure 6 Assessment of the threat “Food-associated infections”

3.6 Unintentional release of dangerous microorganisms from contained systems

Introduction

Dangerous microorganisms include naturally occurring microorganisms which are pathogenic to humans, animals or plants as well as certain genetically modified microorganisms. Microorganisms are grouped into risk groups 1 to 4 according to the degree of risk and kept in containment systems to protect humans and the environment from harmful consequences. In Switzerland, there are four levels of biosafety containment for activities that are broadly consistent with the risk groups of microorganisms. Each biosafety level requires specific safety measures as described by the containment ordinance[9] and the ordinance on the protection of employees from the risks from dangerous microorganisms[10]. Release can occur via different paths; this includes waste, wastewater, reusable materials, outgoing air, carry-over by individuals due to hygiene deficiencies and failure of technical barriers in the event of accidents.

Examples of incidents

— 2014, Belgium
Forty-five litres of concentrated, infectious, poliovirus culture (risk group 2) entered the wastewater system of a pharmaceutical company that produces inactive polio vaccine. The virus remained infectious in the environment for several weeks. The authorities analysed possible transmission paths and warned the general population. Individuals who had come into contact with potentially polluted water were vaccinated against polio. Analyses of downstream water samples were all negative, whereupon no further measures were necessary.

— 2007, Great Britain
In Pirbright, a few miles away from a state-owned foot-and-mouth disease (FMD) reference laboratory and a pharmaceutical company producing inactive FMD virus vaccine, cows became sick with foot-and-moutht disease. Investigations by experts revealed that the highly contagious virus (risk group 4) was not derived from a natural source, but was probably released by a leak in the sewage system of the plants. The outbreak led to the loss of 2,160 animals.

— 2005, USA
Three employees of a Boston University laboratory were exposed to the bacterium *Francisella tularensis*; a causative agent in risk group 3, which can cause the rare disease Tularaemia (or Rabbit fever). The staff thought they were working with a harmless vaccine strain. However, the sample was mixed with a virulent strain. The employees survived, but two had to be hospitalised.

— 1978, Great Britain
After the release of a Smallpox virus (risk group 4) from a research laboratory at the University of Birmingham, a smallpox outbreak occurred with one fatality. The infection probably occurred through the ventilation system, which spread the released virus in the building.

Relevant influencing factors

— Species, risk group and amount of released microorganisms

— Safety measures of the facility

— Quality and condition of technical installations and infrastructure

— Training and risk perception of employees

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9 Containment ordinance, https://www.admin.ch/opc/en/classified-compilation/20100803/index.html

10 Ordinance on the protection of employees from the risks from dangerous microorganisms, https://www.admin.ch/opc/de/classified-compilation/19994946/index.html (in German)

— Number of laboratories with risk classes or security levels 1 to 4 in Switzerland

Hazard scenarios

Significant: Brucella bacteria is released in a biosafety level 2 diagnostic lab. Two employees become infected. Other people are not infected. A few weeks later, both individuals develop symptoms and need to be treated with antibiotics.

Major: In a biosafety level 3 research institution, a tuberculosis pathogen strain is released, which has multidrug resistance to tuberculostatics. Five unprotected employees become infected through inhalation or contact. The event happens in winter, causing employees to confuse the symptoms with a cold and infect others. In total, another ten individuals become infected, one of whom falls sick. The five employees and the additional person are hospitalised and treated with tuberculostatics. They recover but their health remains impaired.

Extreme: A biosafety level 4 research institute is working on a novel variant of a highly pathogenic influenza A/H5N1 avian influenza virus, which, in contrast to the naturally occurring virus, is easily transmitted to humans. Due to an initially unnoticed defect in the ventilation system, virus is released into the environment, which leads to the infection of some wild birds. These transmit the virus to chickens at a nearby farm. Some workers on this farm become sick. A total of 25 people show symptoms of sickness and are hospitalised, of which ten individuals die. The spread of the virus is finally contained by contact tracing, patient isolation and the use of an experimental drug. In a larger area, the slaughter of poultry and monitoring of wild birds is ordered. A larger number of contact individuals in the patients' environment must be supported by social measures (e.g. Care management, organisation of childcare).

Risk analysis

Probability of occurrence: The *significant* scenario is considered to be *likely* because biosafety level 2 laboratories have lower security standards than higher-level laboratories. The scenario *major* is classified as *unlikely*; this is due to high technical and organisational safety standards and only very specialised, well-trained personnel with appropriate protective equipment are allowed to work in such laboratories.

The *extreme* scenario on the other hand, is classified as *very unlikely*, as such experiments are currently not conducted or planned in Switzerland, and in fact would not be approved, therefore such an "accident scenario" is barely conceivable.

Extent of damage: In the *significant* and *major* scenarios, other than the sick individuals, there are no further personal injuries. However, some deaths in the *extreme* scenario are to be expected. Property losses and coping costs are limited to health care costs in all scenarios, except in the *extreme* scenario where significant economic damage due to police countermeasures would have to be quantified. In the *major* and *extreme* scenarios, there would also be damage to Switzerland's reputation and a substantial loss of confidence in the state and institutions.

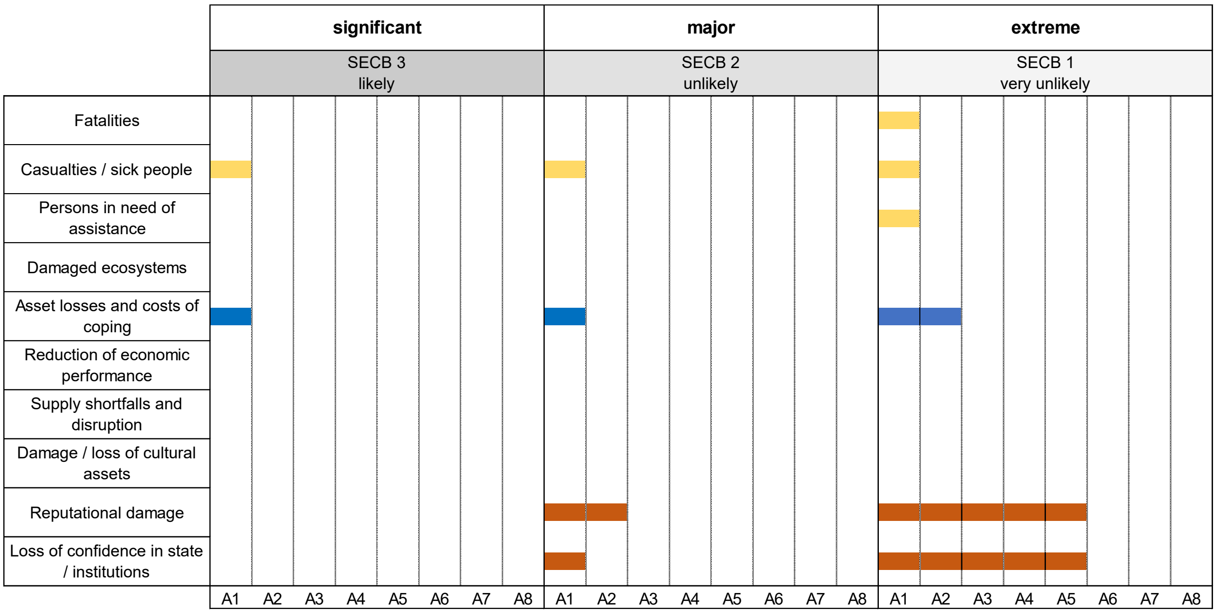

Figure 7 Assessment of the threat “Accidental release of dangerous microorganisms from contained systems”

3.7 Negative impact of new traits in plant varieties developed using classical or genetically engineered breeding techniques

Introduction

Classical plant breeding refers to the selective breeding of plant varieties. Genetically engineered plant breeding involves the transfer of genes from one organism to another. Under certain legal regulations, this also includes the precise change of DNA (genome editing), e.g. by CRISPR technology.

Naturally, plants contain substances that can endanger humans or animals. Breeding may increase the concentrations of such substances or alter their composition in the plant, which may affect the health of humans or animals when consuming such plants. Other possible negative consequences are persistence, invasiveness in the environment or effects of modified cultivation or harvesting techniques on biodiversity.

Classical plant breeding relies on a long history of safe use, which is based on the assessment of the products. By contrast, genetically engineered plant breeding is only 25 years old and judged on a process-orientated basis, which could also be handled differently.[11]

Examples of incidents

— 2009–2012, USA, Canada
In the USA and Canada, wild genetically modified populations became established following the cultivation of genetically-modified oilseed rape (*Brassica napus*). In Japan, where rape is exported, and in Switzerland, where genetically modified oilseed rape is neither cultivated nor imported (invasiveness), a few such plants were also found. Gene flow of *B. napus* has also been detected in the related species *Brassica rapa* (gene transfer).

— From 2000, USA
Genetically engineered Bt plants and Cry proteins interact with target and non-target organisms. In general, no adverse effects on non-target organisms are observed in commercial cultivation, but individual reports from laboratory or field situations have noted adverse effects on lacewings, earthworms, honey bees, and other organisms. However, these reports have also been in part disputed.

— 1960, USA
The Lenape potato was produced by conventional breeding for the production of potato chips. However, the new species had significantly higher concentrations of solanine than other potato species, which led to severe nausea when ingested.

Relevant influencing factors

— Plant type

— New characteristics of the plant variety and their possible intended and unintended, direct and indirect effects on humans, animals or the environment

— the type of use of the plant, the environment involved and the requirements of the methods of cultivation

— Ecological and economic benefits of the new plant varieties

— Political and legal framework regarding the regulation of genetically modified plants

— Further development of the technology, e.g. new technologies where cultivated species are indistinguishable from natural ones

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11 Report of the SECB on new plant breeding procedures, December 2016: https://www.efbs.admin.ch/inhalte/dokumentation/Ansichten/D_Bericht_EFBS_Neue_Pflanzenzuchtverfahren.pdf

Hazard scenarios

Two hazard scenarios are described for the classical/conventional and genetic engineering breeding techniques. A scenario with *extreme* intensity is not realistic for both breeding techniques from the perspective of the SECB. Even the *major* scenario for genetic engineering plant breeding is already overestimated with an occurrence probability of SECB 1 (*very unlikely*); this scenario is almost out of the question. The reason for this is the rigorous regulations, especially in the field of genetic engineering. New products are subject to strict controls and extensive examinations.

Classical plant breeding

Significant: A new variety of strawberry with unrecognised allergic potential enters the Swiss market. At least 500 individuals have allergic reactions and are medically treated. The strawberry variety is withdrawn from the market, resulting in costs for the recall and a price drop for Swiss strawberries.

Major: A new variety of strawberry with unrecognised allergic potential enters the Swiss market. At least 3,000 individuals have allergic reactions and need medical treatment. Five hundred individuals are hospitalised, with one person dying of anaphylactic shock. The strawberry variety is withdrawn from the market, resulting in costs for the recall and a price drop for Swiss strawberries.

Genetically engineered plant breeding

Significant: In Europe and Switzerland, genetically modified oilseed rape with improved oil content and/or insect resistance is cultivated. Genetic engineering makes the plant more persistent and spreads outside the cultivated area. The rapeseed hybridises with related, wild species and becomes a problem in the Swiss agroecosystem. The result is high management costs and reduced crop yields. The more persistent related wild species also spread and lead to changed habitats and loss of biodiversity. The spread of the plants is combated. Human health is not affected. The incident generates a high media presence.

Major: In Europe and Switzerland, genetically modified millet (sorghum) is cultivated, which is cold-tolerant. The millet is able to hybridise with the wild sorghum (Johnsongrass). The millet, the hybrid, as well as the wild cattle millet itself become the biggest weed problem in the Swiss agroecosystem. An area of about 300 km^2 is affected. The consequences are high costs to control the spread of weeds, losses in crop yield and more frequent allergic reactions to pollen from wild sorghum (1'000 - 3'000 affected persons). The incident generates a high media presence.

Risk analysis

The *significant* and *major* scenarios of classical plant breeding are considered *unlikely* and *very unlikely* within the next ten years, new varieties of plants are being regularly developed and marketed, but these rarely have unrecognised allergic potential with major implications. The *significant* and *major* scenarios for genetically engineered plant breeding are both considered *very unlikely* during the next ten years. Extensive safety investigations have been carried out before cultivation in order to exclude negative effects of cultivation. In addition, the cultivation of genetically modified plants in Switzerland is prohibited by a moratorium until 2021.

Ecosystems are affected by the spread of genetically modified plants and their control. Economic damage is caused by control of crop spread and crop failures. In the case of genetically engineered plant breeding, the reputation of Switzerland will be damaged by the high level of media coverage and demonstrations by genetic engineering opponents. In all scenarios there is a loss of confidence of the general population in the state/institutions.

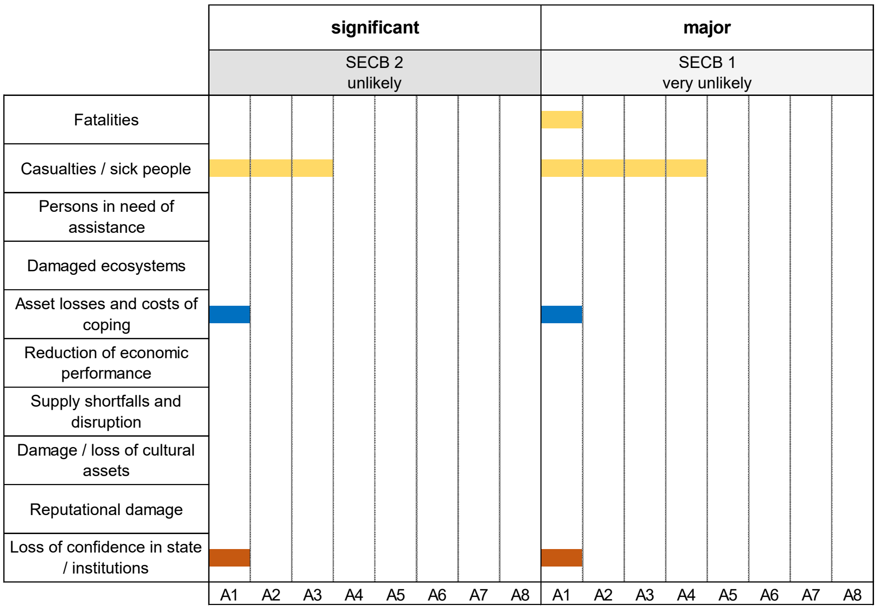

Figure 8 Assessment of the threat “Negative impact of new traits in plant varieties developed using classical breeding techniques”

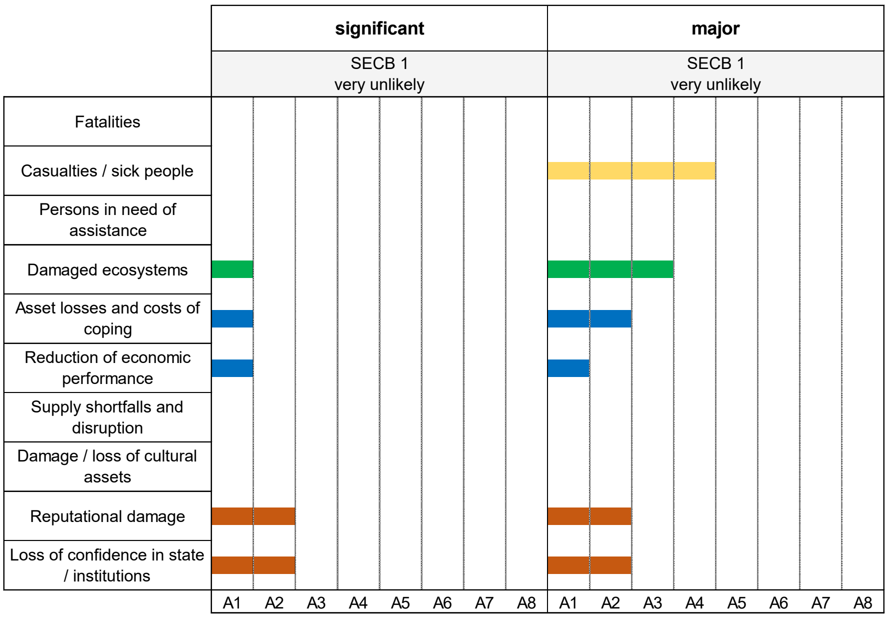

Figure 9 Assessment of the threat “Negative impact of new traits in plant varieties developed using genetically engineered breeding techniques”

4. Comparison and prioritisation

The risks of the seven assessed biological hazards are shown in the risk matrix in Figure 10. The probability of occurrence is on the Y-axis and the monetised extent of damage is shown on the X-axis. The monetisation of the extent of loss was calculated in accordance with the national risk analysis (KNS). It makes it possible to compare the extent of damage of very different hazards.

The risk, the product of probability of occurrence and extent of damage, increases from the bottom left (low probability and small size, green area) to the top right (high probability and large size, red area). The intensities of the three scenarios are marked with the abbreviations S for *significant*, M for *major* and X for *extreme*.

4.1 Consideration of risks using all indicators

The threat of "antibiotic resistance" is the highest risk (Figure 10). All the *significant* and *major* scenarios have significantly higher risks than all other threats. This is due to the high probability of occurrence in combination with the high damage on individuals due to numerous deaths and sickness as well as the high economic damage. Accordingly, the risk of "antibiotic resistance" must get more attention and be reevaluated in the future.

The *significant* scenario for the threat "animal epidemic" has a comparatively high risk, caused by damage in all areas. However, it is only possible to make a limited comparison with the other hazards as only the *significant* scenario is described and not all three intensity levels.

All three scenarios for the risks "invasive plant pathogens", "vector-borne diseases" and "food-associated infections" are in the middle of the risk matrix. In the scenarios of *significant* and *major* risk for “invasive plant pathogens”, there are several overall indicators in the lowest grade A1. The class includes losses of between CHF 0 and 50 million, but the risk of invasive plant pathogens is often in the lower range of this class. Thus, the overall damage and the risks in the present work tend to be overestimated. Nevertheless, these three hazards must also be taken into account in the future; measures must be defined and new developments pursued.

The risk of "release of dangerous microorganisms" poses low risks compared to the other hazards. Release of microorganisms from a laboratory of safety level 2 (*significant* scenario) leads to a low degree of damage, while a release of microorganisms from a laboratory of safety level 3 (*major* scenario) has a low probability of occurrence due to the strict safety requirements. Insofar as the currently applicable safety requirements in Switzerland are fully met, this hazard poses a comparatively low risk.

The hazard "negative impact of new traits in plant varieties developed using classical or genetically engineered breeding techniques" has risks at the lower end of the middle range (classical breeding techniques), and the lower part of the risk matrix (genetically engineered breeding techniques), respectively. The threat "negative impact of new traits in plant varieties developed using genetically engineered breeding techniques" is the only hazard in which the probability of occurrence of both scenarios has been classified as very unlikely, since genetic plant breeding techniques are subject to strict evaluation guidelines before they are used. Overall, the perception of the potential risks of new traits in plant varieties developed using genetically engineered breeding techniques raised in open public debate seem to be significantly higher than the actual biologically quantifiable risks.

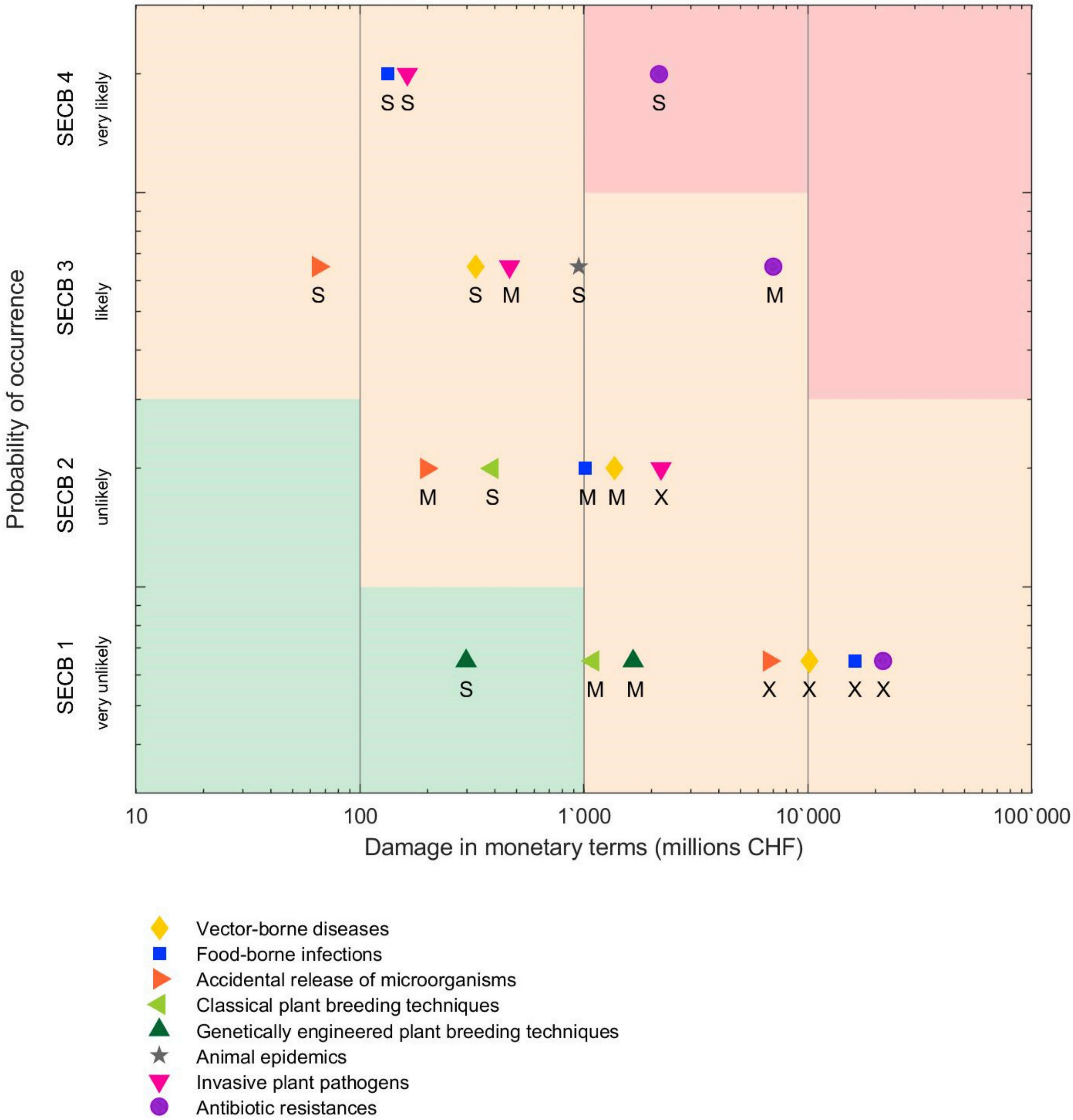

Figure 10 Risk matrix: Consideration of all indicators (S for *significant*, M for *major* und X for *extreme*)

4.2 Consideration of risks with focus on the indicators "Individuals" and "Environment"

The area of expertise of the SECB is biological safety (damage areas for individuals and the environment). To illustrate the biological hazards, Figure 11 shows the risk matrix if only the indicators in the areas of injury to individuals (fatalities, casualties/patients and those in need of support) and the environment (damaged area and duration) are taken into account.

Overall, the results are similar to those in the risk matrix in Figure 10. The threat "antibiotic resistance" has significantly higher risks than all other hazards, the difference being even more pronounced than in Figure 10.

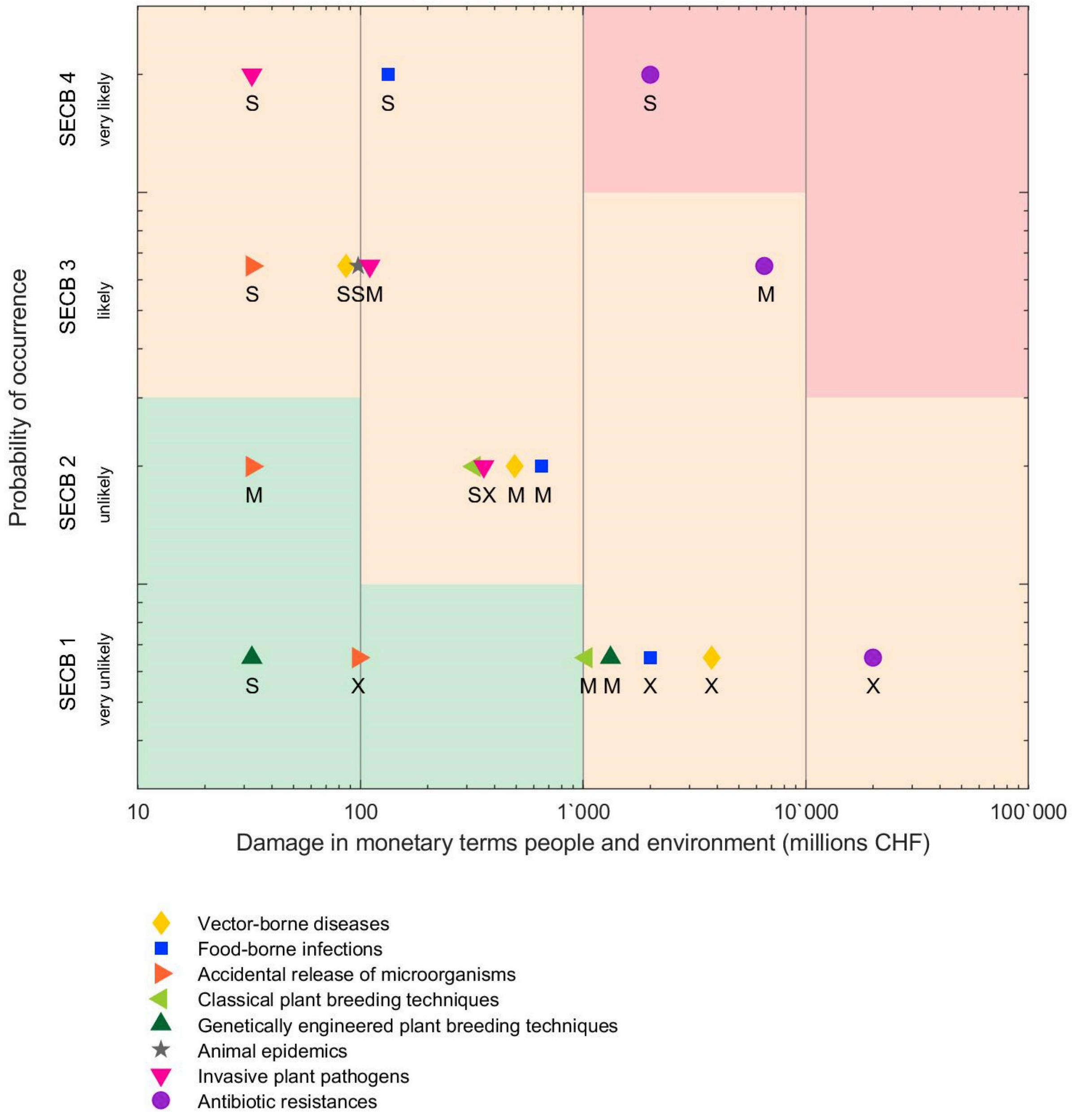

Figure 11 Risk matrix: Individuals and the environment as indicators. The *significant* scenarios for the threats "vector-borne diseases" and "animal epidemics" lie in the same place (S for *significant*, M for *major* and X for *extreme*).

The risks of the threat "invasive plant pathogens" are significantly lower than in Figure 10, as the highly important indicators of financial loss/coping costs, loss of cultural assets and loss of confidence are not taken into account. Above all, harm to ecosystems is responsible for the overall damage.

The risk of an "animal epidemic" is also much lower, since the overall damage is also caused by economic costs, the damaged reputation of Switzerland and the loss of confidence.

The risks associated with "food-associated infections" and "vector-borne diseases" are also lower as is the case in Figure 10 as well.

The lowest risks again stem from the threats of "negative impact of new traits in plant varieties developed using classical breeding techniques", "negative impact of new traits in plant varieties developed using genetically engineered breeding techniques" and "release of dangerous microorganisms", caused by damage to the ecosystems and by the number of patients.

4.3 Further risk presentations

If the two indicators of the economic sector are presented separately, the risks associated with "antibiotic resistance", "animal disease" and "invasive plant pathogens" pose similar risks, followed by the risk of "vector-borne diseases" (Appendix 2).

If the indicators of society loss are presented separately, the *significant* and *major* scenarios for "antibiotic resistances" scenarios still show high risks, as well as the threats arising from "animal epidemics" and "invasive plant pathogens". By contrast, all plant breeding scenarios are in the green (Appendix 2).

5. Conclusion

Hazards with the highest risk: antibiotic resistance

The threat of "antibiotic resistance" has the highest risks for Switzerland in comparison to the other analysed biological hazards. This is the result of the comparatively high probability of occurrence of the three scenarios as well as the greatest impact on individuals, the economy and society.

Multiple hazards with medium risk

The hazards "plant pathogens", "food-associated infections", "animal epidemics" and "vector-borne diseases" present risks in the middle range.

Hazards with low risk

The hazards of "negative impact of new traits in plant varieties developed using classical breeding techniques", "negative impact of new traits in plant varieties developed using genetically engineered breeding techniques" and "release of dangerous microorganisms" have a lower or negligible risk than the other hazards. For the hazard "negative impact of new traits in plant varieties developed using genetically engineered breeding techniques", the risk quantified here is lower in the view of the SECB than that perceived by the general public.

Balanced risk assessment through a broad dialogue

Members of the SECB prepared a dossier for each hazard and made an initial risk assessment. The SECB discussed the very different biological hazards and their risk assessments in the form of two moderated workshops with the help of an expert from the national risk analysis team (KNS). This procedure made it possible to standardise the different assumptions for the estimates of probability of occurrence and extent of damage. For the first time, it is thus possible to directly compare the various hazards and to prioritise them. Through the discussions of the committee the results have been widely supported.

Inclusion of the threat «antibiotic resistance» in KNS?

Since the hazard of "antibiotic resistance" poses a very high risk to Switzerland, it should be included in the next update of the national risk analysis KNS. However, it must be taken into account that the spread of antimicrobial resistance is a development rather than a recurring event, as is normal for the hazards considered in the KNS.

Appendix 1: Basics of risk analysis

The various indicators are described below, for the scaling classes A1 to A3 (Table 3) and A4 to A8 (Table 4).

Table 3 Scaling Classes of indicators according to the KNS (Part I); for more information refer to the KNS methodology report

Damage Area	Indicator	Unit	A1	A2	A3
Individuals	Fatality	Number	≤10	11 – 30	31 – 100
	Casualties/sick	Number	≤100	101 – 300	301 – 1'000
	Support needed	Person Days	≤200'000	200'001 – 600'000	600'001 – 2 Mill.
Environment	Damaged area and duration	km^2 x Year	≤150	151 – 450	>450 – 1'500
Economy	Property damage and coping costs	CHF	≤50 Mill.	51 – 150 Mill.	>150 – 500 Mill.
	Reduction of economic performance	CHF	≤50 Mill.	51 – 150 Mill.	>150 – 500 Mill.
Society	Supply interruptions	Person Days	≤0.5 Mill.	>0.5 Mil. – 1.5 Mill.	>1.5 Mil – 5 Mill.
	Damaged reputations	Intensity x Duration	Few days, topic of medium Importance	Few weeks, topic of medium Importance	Few weeks, topic of medium Importance
	Loss of confidence in state/institutions	Intensity x Duration	Few days, topic of medium Importance	One to a few weeks, topic of medium importance	One to a few weeks, topic of medium importance
	Damage and loss of cultural assets	number x Significance Category	Damage or loss of individual cultural assets of regional significance	Damage to or loss of cultural property of regional importance or individual national importance	Damage or loss of several cultural objects of regional or national importance

Table 4 Scaling classes of Indicators according to the KNS (Part II)

Damage Area	Indicator	A4	A5	A6	A7	A8
Individuals	Fatalities	101 – 300	301 – 1'000	1’001 – 3’000	3’001 – 10’000	>10’000
	Casualties/sick	1’001 – 3’000	3’001 – 10’000	10’001 – 30’000	30’001 – 100’000	>100’000
	Support needed	>2 Mill. – 6 Mill.	>6 Mill. – 20 Mill.	>20 Mill. – 60 Mill.	>60 Mill. – 200 Mill.	>200 Mill.
Environment	Damaged area and duration	>1'500-4’500	>4’500-15’000	>15’000-45’000	>45’000-150’000	>150’000
Economy	Property damage and coping costs	>500 Mill. – 1.5 Bill.	>1.5 Bill. – 5 Bill.	>5 Bill. – 15 Bill.	>15 Bill. – 50 Bill.	>50 Bill.
	Reduction of economic performance	>500 Mill. – 1.5 Bill.	>1.5 Bill. – 5 Bill.	>5 Bill. – 15 Bill.	>15 Bill. – 50 Bill.	>50 Bill.
Society	Supply interruptions	>5 Mill. – 15 Mill.	>15 Mill. – 50 Mill.	>50 Mill. – 150 Mill.	>150 Mill. – 500 Mill.	>500 Mill.
	Damaged reputations	Several weeks, important topics, significant consequences for Switzerland's position and international cooperations	Several weeks, important topics, significant consequences for Switzerland's position and international cooperations	Several weeks, major damage, consequences for Switzerland's position and international cooperations	Some months, major damage, significant consequences for Switzerland's position and international cooperations	Permanent and severe up to irreversible loss of reputation, far-reaching consequences for Switzerland's position and international cooperations
	Loss of confidence in state/institutions	A few to several weeks, significant topics	Several weeks, significant topics	Several weeks, major damage	Several weeks, major damage	Permanent, severe to irreversible loss of general trust
	Damage and loss of cultural assets	Damage or loss of several cultural goods of national importance	Damage or loss of many cultural treasures of national importance	Damage or loss of many cultural goods of national importance and cultural goods under "enhanced protection"	---	---

The marginal costs used for monetisation are shown in Table 5. In contrast to the methodology report of the KNS study, the marginal costs of the indicators for fatalities, casualties/sick individuals, damaged ecosystems and supply bottlenecks were adjusted so that all indicators are equally weighted. This corresponds to the procedure of the Federal Office for Civil Protection (FOCP) in the area of protection of critical infrastructures.[12]

Table 5 Marginal Costs of the scaling classes

Damage Area	Indicator	Unit	Marginal Cost (CHF/Measured variable)
Individuals	Fatalities	Number	5'000'000
	Casualties/sick	Number	500'000
	Support needed	Person days	200
Environment	Damaged area and duration	km^2 x year	333'333
Economy	Property damage and coping costs	CHF	1
	Reduction of economic performance	CHF	1
Society	Supply interruptions	Person days	100
	Diminished public order and domestic security	Person days	500
	Damaged reputation	Intensity x duration	Average of the corresponding class of the other indicators
	Loss of confidence in state/institutions	Intensity x duration	Average of the corresponding class of the other indicators
	Restrictions of territorial integrity	Intensity	Average of the corresponding class of the other indicators
	Damage and loss of cultural assets	Number x importance category	Average of the corresponding class of the other indicators

12 Federal Office for Civil Protection (FOCP); Guide to Critical Infrastructure Protection; Implementation assistance; Bern, July 2018

Appendix 2: Further risk matrices

Figure 12 shows the risks of the seven hazards when only the indicators of the economic sector are presented.

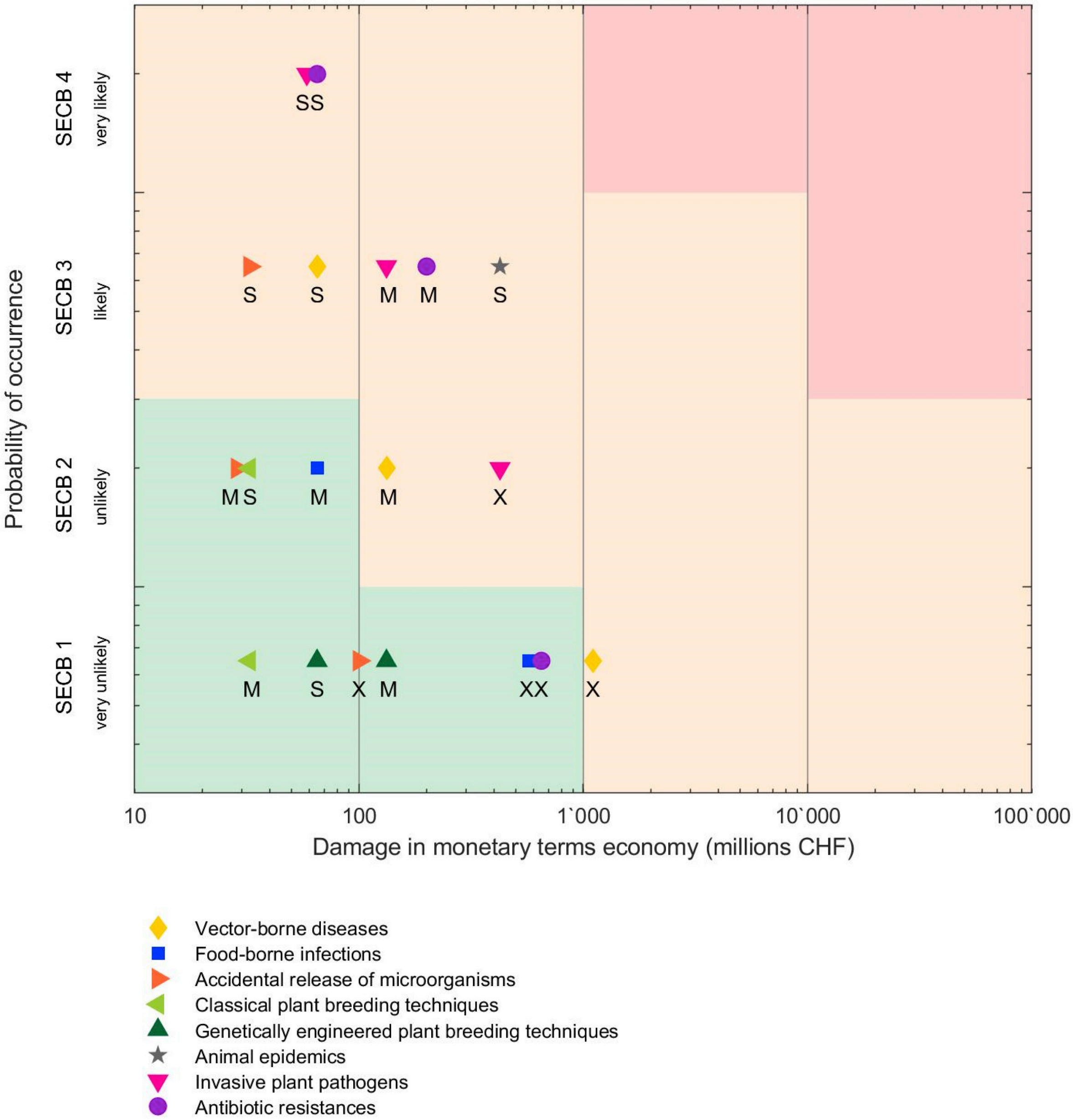

Figure 12 Risk matrix: Economy Indicator. The *significant* scenario of the threat "food-related infections" is not visible, since the scenario does not lead to economic damage (S for *significant*, M for *major* and X for *extreme*).

Figure 13 shows the risks of the seven hazards when only the indicators of the damage area of society are shown.

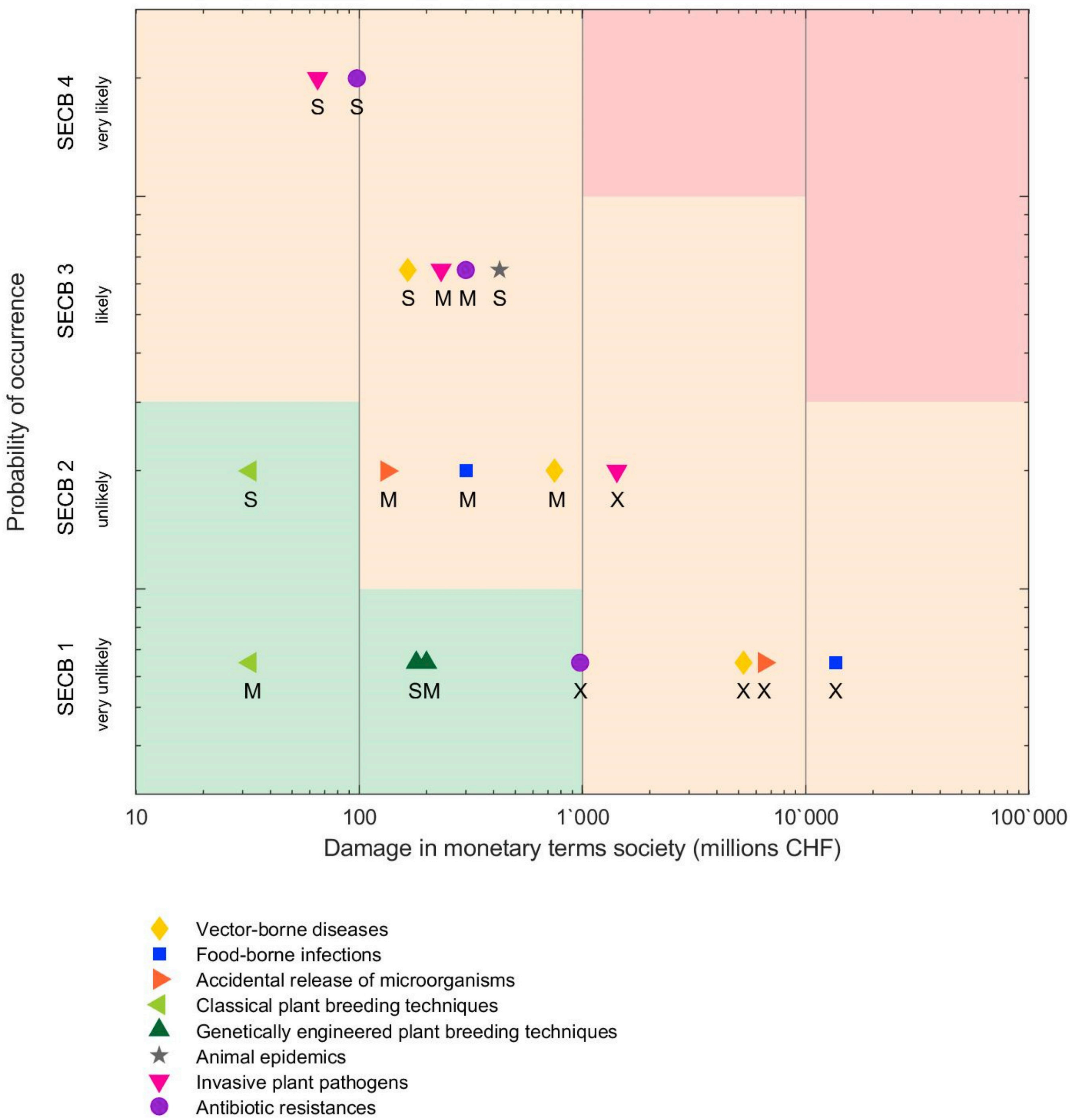

Figure 13 Risk matrix: Society indicators. The *significant* scenario for the hazards "Food-associated infections" and "Release of dangerous Microorganisms" are not visible, as these scenarios do not lead to any society damage (S for *significant*, M for *major* and X for *extreme*).