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# Natech Risk Management: Contributions to the UN/OECD Natech Project

Final report

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# Natech Risk Management: Contributions to the UN/OECD Natech Project

Final report

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**Abstract: Natech Risk Management: Contributions to the UN/OECD Natech Project**

This final report summarizes the work results of the activities undertaken to support the UN/OECD Natech[1] II project. The report is based on the report submitted to the Organisation for Economic Co-operation and Development (OECD) Working Group on Chemical Accidents (WGCA) before its 28th meeting and the comments received. The contents can be divided into four sub-categories:

1. The final evaluation of the results of the survey by the steering group;
2. A description of the sessions and the presentations made at the UN/OECD Natech-II-Workshop;
3. A description of the record of good practice examples in Natech risk management;
4. The recommendations generated at the workshop.

**Kurzbeschreibung: Natech-Risikomanagement – Beiträge zu dem UN/OECD Natech Project**

Dieser Abschlussbericht fasst die Arbeitsergebnisse der zur Unterstützung des UN/OECD Natech[2] II Projekts unternommenen Aktivitäten zusammen. Der Bericht basiert auf dem der Organisation für wirtschaftliche Zusammenarbeit und Entwicklung (OECD) Arbeitsgruppe Chemieunfälle (WGCA) vor ihrer 28. Sitzung vorgelegten Bericht sowie den daraufhin eingegangenen Kommentaren. Die Inhalte lassen sich in vier Überthemen unterteilen:

1. Die finale Auswertung der Ergebnisse der Befragung durch die Steuerungsgruppe;
2. Eine Beschreibung der Sessions sowie der beim UN/OECD Natech-II-Workshop gehaltenen Präsentationen;
3. Eine Beschreibung des Verzeichnisses mit Beispielen guter Praxis im Natech Risikomanagement;
4. Die beim Workshop generierten Empfehlungen.

[1] Natural Hazard Triggering Technological Accident (here: chemical accident)

[2] Natural Hazard Triggered Technological Accident (durch Naturgefahren ausgelöster technischer Unfall, hier: Unfall unter Beteiligung gefährlicher Stoffe)

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## List of abbreviations

| | |
|---|---|
| **APELL** | Awareness and Preparedness for Emergencies at Local Level |
| **ARDEX** | Association of Southeast Asian Nations (ASEAN) Regional Disaster Emergency Response Simulation Exercise |
| **ASEAN** | Association of Southeast Asian Nations |
| **BBK** | Federal Office of Civil Protection and Disaster Assistance |
| **CA** | competent authorities |
| **COMAH** | Control of Major Accident Hazards |
| **EADRCC** | Euro-Atlantic Disaster Response Coordination Centre |
| **EC** | European Commission |
| **EC ERCC** | European Commission Emergency Response Coordination Centre |
| **EEWS** | Earthquake Early Warning System |
| **EFAS** | European Flood Awareness System |
| **EIA** | Environmental Impact Assessment |
| **eMars** | Major Accident Reporting System |
| **EPR** | Environmental Permitting Regulations |
| **EU** | European Union |
| **FEAT** | Flash Environmental Assessment Tool |
| **FRD** | Lithuanian Fire and Rescue Department |
| **GDACS** | Global Disaster Alert Coordination System |
| **GSM** | Global System for Mobile Communication |
| **HELCOM** | Helsinki Commission |
| **ICCARP** | Integration of Climate Change into Regulatory Practice |
| **IED** | Industrial Emission Directive |
| **INERIS** | L'Institut national de l'environnement industriel et des risques (French National Institute for Industrial Environment and Risks) |
| **IPCC** | International Panel on Climate Change |
| **IPPC** | Integrated Pollution Prevention and Control |
| **ISPRA** | Istituto Superiore per la Protezione e la Ricerca Ambientale (Italian National Institute for Environmental Protection and Research) |
| **JEU** | United Nations Environment/Office for the Coordination of Humanitarian Affairs (OCHA) Joint Unit |
| **JRC** | European Commission Joint Research Centre |
| **LPG** | Liquefied Petroleum Gas |
| **Natech** | Natural Hazard Triggered Technological Accident (durch Naturgefahren ausgelöster technischer Unfall - hier chemischer Unfall) |

| | |
|---|---|
| **NATO** | North Atlantic Treaty Organization |
| **OECD** | Organization for Economic Co-operation and Development |
| **PPS 25** | Planning Policy Statement 25 |
| **PWIS** | Public Warning and Information System |
| **TRAS** | Technische Regeln für Anlagensicherheit (Technical Rules on Process Safety) |
| **TWG 2** | European Commission Technical Working Group on Seveso II Inspections |
| **UN** | United Nations |
| **UNECE** | United Nations Economic Commission for Europe |
| **UNESCO** | United Nations Educational, Scientific and Cultural Organization |
| **UNISDR** | United Nations Office for Disaster Risk Reduction |
| **UN OCHA** | United Nations Office for the Coordination of Humanitarian Affairs |
| **UK** | United Kingdom |
| **US CSB** | United States Chemicals Safety Board |
| **WGCA** | Working Group on Chemical Accidents |

## Summary

This final report summarises the work results of the activities undertaken to support the UN/OECD Natech[3] II project. The report is based on the report submitted to the Working Group on Chemical Accidents (WGCA of the OECD) before its 28th meeting and the comments received. The contents can be divided into four sub-categories:

1) The final evaluation of the results of the survey by the steering group;
2) A description of the sessions and the presentations made at the UN/OECD Natech-II-Workshop;
3) A description of the record of good practice examples;
4) The recommendations generated at this workshop.

The activities carried out to generate these results are listed in the table below.

A policy paper with recommendations for the consideration of Natechs in the field of climate change adaptation is published in a separate report and a four-page summary for policy makers (both in German).

| Activities | Work results |
|---|---|
| Evaluation of the second survey of OECD and non-OECD countries | • The results of the survey showed that countries are catching up on rules, codes and/or guidelines specifically dealing with natural hazards to which they are particularly vulnerable. In addition, the countries surveyed lack guidelines for Natech risk management and strategies or programmes to address the problem of Natech events.<br>• The self-estimated effectiveness of Natech accident prevention legislation has decreased slightly over an 8-year timeframe. This could be due to the increasing recognition of Natech as a serious threat requiring adequate risk management and a greater awareness of it among policy makers. However, such changes in the perception of effectiveness can also be attributed to differences in the sample of countries/institutions that responded to the survey. It should also be noted that the gaps and deficiencies were more specific and better defined compared to the 2009 results. |
| Record of examples of good practice on Natech risk management | • The evaluation of the first survey by the EC-Joint Research Center (JRC), the Natech-I-Workshop in 2012, the second survey of states and organisations, as well as our own research on examples of good practice in Natech risk management, served as the basis for the first draft of the list of examples of good practice, which was subsequently agreed with the client and the steering group.<br>• A template for the individual examples was drawn up and agreed. The examples offer a quick, easy-to-understand overview of the key points of the cases mentioned in the form of one- or two-page fact sheets.<br>• The directory was revised and maintained throughout the project, particularly after the 27th and 28th sessions of the WGCA, and after the UN/OECD Natech-II-Workshop.<br>• The assessment of the individual examples lies with the steering group of the WGCA for its Natech project. |
| Planning and Organisation of the OECD / UN-Natech-II Workshop | • The topic and format of the UN/OECD Natech-II-Workshop in 2018 were determined in consultation with the client.<br>• A "Call for Papers" was used to recruit speakers for this workshop. |


[3] Natural Hazard Triggered Technological (here: chemical) Accident

| Activities | Work results |
|---|---|
| | • The programme was designed on the basis of the abstracts for the presentations received.<br>• The discussion document for this workshop was prepared. It contained chapters on the evaluation of the 2017 survey of states and organisations, the current state of research on Natech risk management based on the abstracts submitted by the speakers, a summary with examples of good practice and draft recommendations for action as a basis for discussion in the individual workshop sessions.<br>• The proceedings for the workshop were prepared and printed for the optimal preparation of the participants. These included the agenda, the report on the 2017 survey, the discussion document, the abstracts, the list of participants and some practical advice.<br>• The workshop was accompanied by the project team. The results of the individual sessions were recorded in evening sessions and transformed into concrete recommendations to supplement the OECD Guiding Principles. |
| Report to the 28th WGCA | • The contents of the discussion document, which was updated on the basis of the results of the UN/OECD Natech-II-Workshop, including proposals for updating or concretising the OECD Guiding Principles, were forwarded to the WGCA in a report and presented during its 28th session, as was the record of good practice examples.<br>• Subsequently, the report was slightly adapted according to the comments from the WGCA and sent to the OECD for publication. |
| Policy paper with recommendations for action for national bodies and decision-makers | • The paper (a sub-report in German) first describes the possible impacts of climate change on the intensity, frequency and duration of natural hazard sources, while also discussing the extent to which natural hazards can have a negative impact on installations. The paper then identifies the need for action for German stakeholders arising from the OECD Guiding Principles (OECD 2003) (including the Natech Addendum (OECD 2015) and the findings of the UN/OECD Natech workshops.<br>• In order to discuss the final use of the sub-report and its target audience and to identify further need for revision of the sub-report, a joint meeting was held between UBA Division III. 2.3 Plant Safety and UBA Division I 1.6 KomPass - Competence Centre Climate Impacts and Adaptation. The Action Plan Adaptation (APA) of the German Adaptation Strategy to Climate Change (DAS), which is accompanied by the Inter-Ministerial Working Group on Adaptation Strategy (IMAA), was highlighted as a possible addressee.<br>• Upon request during the meeting, the contents of the paper were summarised in a three-page short paper for policy makers (in German). |

## Zusammenfassung

Dieser Abschlussbericht fasst die Arbeitsergebnisse der zur Unterstützung des UN/OECD Natech[4] II Projekt unternommenen Aktivitäten zusammen. Der Bericht basiert auf dem der Arbeitsgruppe Chemieunfälle der OECD (WGCA) vor ihrer 28. Sitzung vorgelegten Bericht sowie den daraufhin eingegangenen Kommentaren. Die Inhalte lassen sich in vier Überthemen unterteilen:

1) Die finale Auswertung der Ergebnisse der Befragung durch die Steuerungsgruppe;
2) Eine Beschreibung der Sessions sowie der beim UN/OECD Natech-II-Workshop gehaltenen Präsentationen;
3) Eine Beschreibung des Verzeichnisses mit Beispielen guter Praxis;
4) Die beim Workshop generierten Empfehlungen.

Die Aktivitäten, die durchgeführt wurden, um diese Ergebnisse zu generieren sind in der unten stehenden Tabelle aufgeführt.

Ein Politikpapier mit Handlungsempfehlungen zur Berücksichtigung von Natechs im Bereich Klimaanpassung wird in einem separaten Bericht sowie eine vierseitige Kurzfassung für politische Entscheidungsträger*innen veröffentlicht (beide in Deutsch).

| Aktivitäten | Arbeitsergebnisse |
| --- | --- |
| Auswertung der zweiten Befragung der OECD- und Nicht-OECD Länder | • Die Ergebnisse der Umfrage zeigten Nachholbedarf der Länder bei Regeln, Kodizes und/oder Leitlinien, die sich speziell mit den Naturgefahren befassen, für die die Länder besonders anfällig sind. Außerdem fehlt es in den befragten Ländern an Richtlinien für das Risikomanagement von Natechs, und an Strategien oder Programmen zur Lösung des Problems der Natech-Ereignisse.<br>• Die selbst geschätzte Wirksamkeit der Vorschriften zur Natech-Unfallverhütung hat sich in einem Zeitrahmen von acht Jahren leicht verringert. Dies könnte damit zusammenhängen, dass Natechs zunehmend als ernsthafte Bedrohungen erkannt werden, die ein angemessenes Risikomanagement erfordern, und einem stärkeren Bewusstsein der politischen Entscheidungsträger*innen darüber. Solche Veränderungen in der Wahrnehmung der Wirksamkeit lassen sich jedoch auch auf die Unterschiede in der Stichprobe der Länder/Institutionen zurückführen, die auf die Umfrage geantwortet haben. Es ist auch festzustellen, dass die Lücken und Mängel im Vergleich zu den Ergebnissen im Jahr 2009 spezifischer und besser definiert wurden. |
| Verzeichnis mit Beispielen guter Praxis zum Natech Risikomanagement | • Die Auswertung der ersten Befragung durch das EC-Joint Research Center (JRC), des Natech-I-Workshops 2012, der zweiten Befragung von Staaten und Organisationen sowie eigene Recherche zu Beispielen guter Praxis im Natech Risikomanagement, dienten als Grundlage für den ersten Entwurf des Verzeichnisses mit Beispielen guter Praxis, der anschließend mit dem Auftraggeber und der Steuerungsgruppe abgestimmt wurde.<br>• Eine Formvorlage für die einzelnen Beispiele wurde erstellt und abgestimmt. Die Beispiele bieten in Form von ein- bis zweiseitigen Fact-Sheets einen raschen, einfach zu erfassenden Überblick über die Kernpunkte der genannten Fälle.<br>• Das Verzeichnis wurde über den gesamten Verlauf des Projekts überarbeitet |


[4] Natural Hazard Triggered Technological Accident (durch Naturgefahren ausgelöster technischer Unfall, hier: Unfall unter Beteiligung gefährlicher Stoffe)

| Aktivitäten | Arbeitsergebnisse |
|---|---|
| | und gepflegt, insbesondere nach der 27. Und 28. Sitzung der WGCA, sowie nach dem UN/OECD Natech-II-Workshop.<br>• Die Beurteilung der einzelnen Beispiele liegt bei der Arbeitsgruppe, die von der WGCA für das Natech Projekt eingerichtet wurde. |
| Planung und Organisation des OECD / UN-Natech-II-Workshops | • Themenstellung und Format des Workshops wurden in Abstimmung mit dem Auftraggeber festgelegt.<br>• Durch einen „Call for Papers“ wurden Redner*innen für den Workshop akquiriert.<br>• Auf Basis der eingegangenen Vorträge wurde das Programm gestaltet.<br>• Das Diskussionsdokument für den Workshop wurde erstellt. Es beinhaltete Kapitel zur Auswertung der Befragung von Staaten und Organisationen von 2017, den aktuellen Forschungsstand zum Thema Natech Risikomanagement anhand der eingereichten Abstracts der Redner*innen, eine Zusammenfassung mit Beispielen guter Praxis sowie Entwürfe für Handlungsempfehlungen als Diskussionsgrundlage für die einzelnen Workshop-Sessions.<br>• Die sog. Proceedings für den Workshop wurden zur optimalen Vorbereitung der Teilnehmer*innen erstellt und gedruckt. Diese beinhalteten die Agenda, den Bericht über die Umfrage von 2017, das Diskussionsdokument, die Abstracts, die Teilnehmer*innenliste und einige praktische Hinweise.<br>• Der Workshop wurde durch das Projektteam fachlich begleitet. So wurden Fachreferate gehalten und in abendlichen Sitzungen die Ergebnisse der einzelnen Sessions festgehalten und in konkretisierte ergänzende Empfehlungen zu den OECD Guiding Principles umgewandelt. |
| Bericht an die 28. WGCA | • Die aufgrund der Ergebnisse des OECD / UN-Natech-II-Workshops fortgeschriebenen Inhalte des Diskussionsdokumentes, einschließlich Vorschlägen zur Fortschreibung oder Konkretisierung der OECD Guiding Principles wurden in einem Bericht an die WGCA weitergeleitet und während der Sitzung, ebenso wie das Verzeichnis mit Beispielen guter Praxis, vorgestellt.<br>• Im Anschluss wurde der Bericht entsprechend der Kommentare aus der WGCA leicht angepasst und der OECD mit der Bitte um Veröffentlichung zugesandt. |
| Politikpaper mit Handlungsempfehlungen für nationale Gremien und Entscheidungsträger *innen | • Das „Politikpapier“ (Teilbericht in Deutsch) beschreibt zunächst die möglichen Einflüsse des Klimawandels auf die Intensität, Häufigkeit und Dauer natürlicher Gefahrenquellen, wobei es weiterhin darauf eingeht, inwieweit sich die Naturgefahren auf Anlagen negativ auswirken können. Darauf folgend zeigt das Papier den Handlungsbedarf für deutsche Stakeholder auf, der sich aus den OECD Guiding Principles (OECD 2003)(einschließlich des Natech-Addendums (OECD 2015) sowie aus den Erkenntnissen der UN/OECD Natech-Workshops ergibt.<br>• Um über die Nutzung des Teilberichts und dessen Zielpublikum zu beraten und weiteren Überarbeitungsbedarf am Teilbericht auszumachen, fand ein gemeinsames Treffen des UBA Fachgebiets III. 2.3 Anlagensicherheit mit dem UBA Fachgebiet I 1.6 KomPass - Kompetenzzentrum Klimafolgen und Anpassung statt. Hierbei wurde der Aktionsplan Anpassung (APA) der Deutschen Anpassungsstrategie an den Klimawandel (DAS), die von der Interministeriellen Arbeitsgruppe Anpassungsstrategie (IMAA) begleitet wird, als möglicher Adressat hervorgehoben.<br>• Auf Nachfrage während des Treffens wurden die Inhalte des Papiers in einem dreiseitigen Kurzpapier für politische Entscheidungsträger*innen zusammengefasst (in Deutsch). |

# 1 Introduction

As the earthquake and tsunami in Japan 2011, or the 2017 hurricane season and specifically Hurricane Harvey showed, major natural events can lead to the occurrence of Natechs (**Na**tural Hazard Triggered **Tech**nological (here: chemical) Accidents), which further increase the already high damages from natural events and may impede recovery and reconstruction thereafter. But also relatively minor events such as cold spells or even localized hazards such as lightning can cause chemical accidents.

In addition, climate projections for some natural hazards show that their frequency and in some cases their intensity will increase in the years and decades to come. Consequently, the risk of Natechs increases as well. Therefore, Natechs must be recognized as serious risks that require adequate risk management efforts.

Natech risks have certain properties that set them apart from other chemical accidents. Some of them may be:

1. The triggering, propagation, and consequences of Natechs may not be covered by "conventional" chemical accident scenarios, used for design and layout of facilities.
2. Natech risk management requires the involvement of experts for natural hazards like meteorologists, hydrologists, geologists and in many cases of hydraulic or civil engineers; the knowledge of these experts must be integrated in the risk management for "chemical" facilities which requires an intensive cooperation with experts for safety of installations.
3. Less extreme Natural hazards also have the potential to cause Natechs.
4. Climate change can cause some natural hazards to occur at locations where they have never been observed before. Also new hazards, such as the rise of sea level, are becoming increasingly important. In summary, there are many new developments that go beyond the traditional design of plants with hazardous substances.
5. Natural hazards can affect several installations at the same time and/or they can cause a series of Natechs.
6. Natural Hazards can trigger cascading events, e.g. one natural hazard may trigger another one.
7. In case of natural disasters, the vulnerability of the population will be increased; a Natech in these situations will have more severe consequences then an equivalent chemical accident at other times.
8. During natural hazards/natural disasters, emergency responders may be engaged in mitigating the consequences for the population, so their availability and capability for mitigating triggered chemical accidents can be limited.

Natech Risk Management may thus require measures usually not covered by chemical accident management.

Therefore the Organisation for Economic Co-operation and Development (OECD) Working Group on Chemical Accidents (WGCA) decided in 2008 to include a project on the "Control of the Impact of Natural Hazards on Chemical Installations" in its 2009 to 2012 work programme. The EC Joint Research Centre (JRC) contributed much to this project by a survey of Natechs (survey 2009). A (first) workshop on Natech Risk Management was held in 2012 in Dresden, Germany (Natech-I-Workshop). Based on the Discussion Document, the results of presentations, and discussions at this workshop, recommendations were developed and accepted by the WGCA. These recommendations accumulated in the “Natech-Addendum” (OECD 2015) to the OECD Guiding Principles for Chemical Accident Prevention and Response (OECD 2003).

In 2015, due to a proposal by UN Environment / OCHA Joint Unit, the WGCA decided to continue the Natech Project as part of its 2017 to 2020 work programme. A second survey on Natech Risk Management was conducted (survey 2017) and a (second) workshop on Natech Risk Management (UN/OECD Natech-II-Workshop) was held in September 2018 in Potsdam, Germany. While the focus of the Natech-I-project was on the drafting of recommendations to be added to the OECD Guiding principles, the focus of the UN/OECD Natech-II-Workshop was on the identification and communication of examples of good practice in Natech Risk Management.

This report summarizes the work of the activities undertaken to support the UN/OECD Natech-II-project. The report is based on the report submitted to the OECD WGCA before its 28th meeting in 2018 and the comments received thereafter. The contents can be divided into four subcategories:

1. The final evaluation of the results of the surveys by the steering group;
2. A description of the sessions and the presentations made at the UN/OECD Natech-II-Workshop;
3. A description of the elaborated record of good practice examples;
4. The recommendations generated at the workshop.

The record of examples of good practice in Natech Risk Management is published separate and shall be a living instrument for documentation of new and additional examples. It shall allow to get an overview on these examples as a basis for planning of further activities to improve Natech Risk Management.

The recommendations elaborated on the basis of the presentations and discussions at the UN/OECD Natech-II-Workshop need further discussion in the WGCA before they may be introduced in the OECD Guiding Principles during its ongoing revision process.

Further study is required concerning the extent to which public and private stakeholders are taking Natech risks into account, in which areas they are well-prepared and how remaining gaps can be closed. Improvement of cooperation will be required, especially between disaster risk reduction according to the Sendai Framework for Disaster Risk Reduction and Chemical Accident Prevention, Preparedness and Response. The increase of knowledge about the effects of climate change on Natech risks will cause an increasing demand to improve the consideration of Natech risks in chemical accidents risk management.

# 2 Evaluation of the 2017 OECD Natech Survey

## 2.1 Background

To continue the UN/OECD Natech project, first, a second survey on Natech risk management was conducted among OECD member countries in 2017. The initial deadline for responses was 31st of July 2017, later extended to 21st of August. The core purposes of the survey were the following:

1. identify examples of good practices in Natech Risk Management,
2. assess risk management practices and awareness of Natechs,
3. identify needs and/or limitations in implementing Natech risk reduction strategies, and
4. identify where progress has been made since the first survey that was conducted in 2009 and which gaps remain.

## 2.2 The 2009 Survey

The survey discussed here, builds on updates and extends a first survey on Natech Risk Management, which was conducted in 2009 and answered by 17 countries. According to the survey report from 2009, developed by the EC JRC, many respondents had indeed recognized natural hazards as a potential risk source for chemical facilities, yet the report also cautioned that a more strategic approach to reduce Natech risks was lacking.

## 2.3 The 2017 Survey

The survey covers 22 areas with relevance for Natech Risk Management and contains 77 questions on Natechs and natural disaster risk management, as well as four questions asking for the respondent's background. The 22 Natech-related areas are sorted into four categories:

I. Regulations for the prevention and mitigation of Natechs;

II. Natech events data collection and retrieval;

III. Natech awareness and risk reduction;

IV. Consideration of natural hazards and Natech risks.

The survey encompasses two types of answers, those in which respondents provide information and facts and those with an evaluation of the respondents. Furthermore the questions are answered in four different ways (open-ended, dichotomous, rating-scales and multiple-choice answers).

## 2.4 Differences Between the Survey in 2009 and in 2017

Even though the main topics coincide in both surveys, some differences can be identified. The 2017 survey is more comprehensive and builds on a higher number of questions than the survey in 2009. Furthermore, the structure of the surveys is different as can be seen in table 1. There is a part describing where progress has been made since the first survey in 2009 and which gaps remain (parts I, II and III). Part IV is new and essentially serves the identification of examples of good practice. Besides, part III from 2009 was removed since the collection and evaluation of reports about Natechs is not at the core of the 2017 evaluation.

**Table 1: Structure of Survey 2009 and 2017**

| Survey 2009 | Survey 2017 |
|---|---|
| I Regulations for the prevention and mitigation of Natechs | I Regulations for the prevention and mitigation of Natechs |
| II Natech events data collection and retrieval | II Natech events data collection and retrieval |
| III Learning from Natech accidents: Case histories | |
| IV Natech awareness and risk reduction | III Natech awareness and risk reduction |
| V Identifying needs and limitations | |
| | IV Consideration of natural hazards and Natech risks |

From the 17 countries that replied to the questions from the 2009 survey (Australia, Austria, Czech Republic, France, Germany, Iceland, Italy, Korea, Luxemburg, Netherlands, New Zealand, Norway, Poland, Sweden, Switzerland, the United Kingdom and the United States of America) all are OECD member countries and 10 are members of the European Union as well.

In 2017 only 14 different countries but an additional three institutions from science and industry responded to the questionnaire. From these 14 countries, 13 are OECD member countries of which nine are also members of the European Union. The participating countries are Austria, Colombia, Estonia, Finland, France, Germany, Japan, Korea, Lithuania, New Zealand, Norway, Sweden, Poland, and United Kingdom.

Hence, the group of participating countries differed between 2009 and 2017, which means that comparing the results of both surveys may not be representative. The nine countries coinciding in both surveys are the following: Austria, France, Germany, Korea, New Zealand, Norway, Sweden, Poland, and United Kingdom. It is observed that issues such as effects of climate change on Natech risks and Natech risks in risk communication were included in the 2017 survey due to their growing relevance at the international level. Though strictly speaking, a comparison between the surveys conducted in 2009 and 2017 would only be possible for the nine coinciding countries, this analysis will attempt to compare both sets of answers. The reason for this approach is that the previous study from 2009 concluded that additional answers had shown to be somewhat congruent to the previously received ones, from which this report concludes that an overall picture can be drawn.

It needs to be further noted that the number of responses does not allow reaching robust conclusions about the status of natural hazard and Natech risk management across the OECD.

In addition, the quality of answers varied, with some respondents giving detailed accounts of their national-level policies and programs, providing links to websites with legal texts and further information, while others left entire blocks of questions unchecked. Given the volume of the survey this is not entirely surprising, yet it does pose a challenge to the analysis.

## 2.5 Examples of Good Practice

The questionnaire asked for 16 possible areas in which examples of good practice in Natech risk management might be found. There was wide variation in the replies, revealing that in some areas many responding countries have taken significant steps, while in others considerable work remains to be done.

Of the 14 governmental respondents, 12 replied that their natural hazard and multi-hazard early warning systems would qualify as examples of good practice, and 11 said the same about their systems of natural hazard mapping.

There was a mixed picture on regulations and guidelines for chemical accident prevention and mitigation, of which eight respondents replied to have examples of good practice. Seven respondents indicated to have examples of good practice of natural hazards being taken into consideration in safety management at hazardous installations. Meanwhile, another six noted they had good practice examples on international cooperation in mapping and early warning systems. Four positive answers were given to each of the questions about good practice examples in design and construction of installations, in safety reports and documents, and in emergency plans. Five respondents replied to have examples of good practice in the consideration of natural hazards in operating procedures, while three gave positive answers in the field of siting and land-use planning.

Effects of climate change on Natech risks have thus far rarely been specifically considered in Natech risk management. Only three governmental respondents indicated to have good practice examples of considerations of effects of climate change in their risk analyses for hazardous installations. While merely two respondents answered that they held a good practice example considering effects of climate change in licensing of hazardous installations. Other weak spots for examples of good practice appear to be risk analysis for hazardous installations, with only three respondents indicating an example of good practice, and education and training, which was answered positively by just one respondent, yet without providing any additional information on possible content.

The description of the reported examples of good practice in Natech Risk Management will be subject of a separate report, but the system of this report on good practice examples and one example will be described within chapter 7.

# 3 Results of the 2017 OECD Natech Survey

## 3.1 Regulations for the Prevention and Mitigation of Natechs

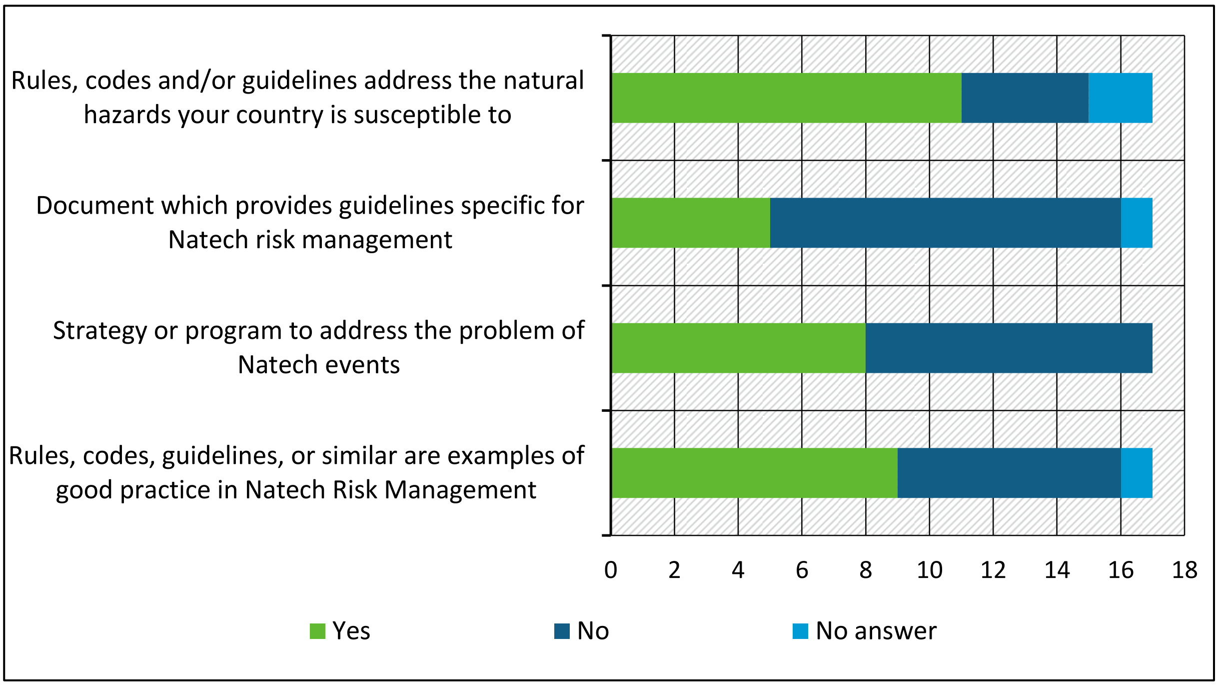
### 3.1.1 Regulations and Guidelines for Chemical-Accident Prevention and Mitigation and Consideration of Natechs

As in the survey of 2009, the first block of questions aims at identifying regulations for chemical-accident prevention and natural-disaster management that are in place, as well as technical codes and standards that consider the impact of natural hazards. In addition, the 2017 survey also asked participants to give information regarding guidelines, strategies, programs and examples of good practices specific for Natech Risk Management.

On the one hand, it can be noted that all (n=17) respondents that provided answers to the questionnaire oversee prevention and mitigation of chemical accidents (question 1a) while almost all countries (88%) indicated rules, codes or guidelines used in the particular country related to chemical accident prevention and mitigation (question 1b). Nevertheless, only eleven respondents out of 17 (65%) assert that these rules, codes and/or guidelines also address the natural hazards their country is susceptible to (question 1c). In the 2009 survey, 76% had positively replied to this question. The result of this first component could be interpreted as a lack of efforts by OECD countries in terms of rules, codes and/or guidelines that specifically address natural hazards to which countries are especially vulnerable. However, another possible interpretation for the difference between years can be that after undertaking first steps forward in Natech Risk Management, stakeholders have become more aware of the shortages that are in place in their countries.

On the other hand, only 35 % of the respondents in 2017 indicated to have a document which provides guidelines specific for Natech Risk Management (question 1d) while 47% are currently developing a strategy or program to address the issue of Natech events (question 1e). This number shows the necessity of OECD countries to continue working on this issue.

**Figure 1: Consideration of Natech Risks in Regulations and Guidelines for Chemical-Accident Prevention and Mitigation in 2017 (Questions 1c, 1d, 1e, 1f)**

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The following good practice examples from United Kingdom and Germany have been selected from the information given by the countries answering question 1f on rules, codes, guidelines, technical codes, standards, strategies or programs that can be an example of good practice in Natech Risk Management.

**Good Practice Example: Flooding, Safety Reports for Sites in United Kingdom**

Since flooding is the most common occurring natural disaster in the UK, the Environment Agency published a guide for sites regulated under EPR (Environmental Permitting Regulations) and COMAH (Control of Major Accident Hazards) (EA 2012). It advises the site operators to prepare safety reports for their sites and to take into account environmental hazards at all stages of construction and equipping.

In order to prepare for flooding events, the guide advises site operators to: 1) evaluate the site's flooding risk and check regularly for flood warnings, 2) to obtain site topography and more detailed flood modelling (can be acquired at the UK Environment Agency office), 3) design an emergency plan for the case of flooding events including appropriate action measures and necessary information distribution, and 4) to take measures to improve flood resilience in general like the optimization of storage for hazardous substances, increasing protection of safety critical utilities, or improved interaction of off-site emergency response.

**Good Practice Example: Flooding, the 310 Technical Rule on Process Safety in Germany**

In 2012, the German Technical Rules on Process Safety 310 („Technische Regel für Anlagensicherheit" (TRAS 310) entered into force, which sets out a procedure for operators to comply with Germany's Major Accidents Ordinance. The described four-step procedure serves to protect establishments against accidents due to flood and heavy rainfall.

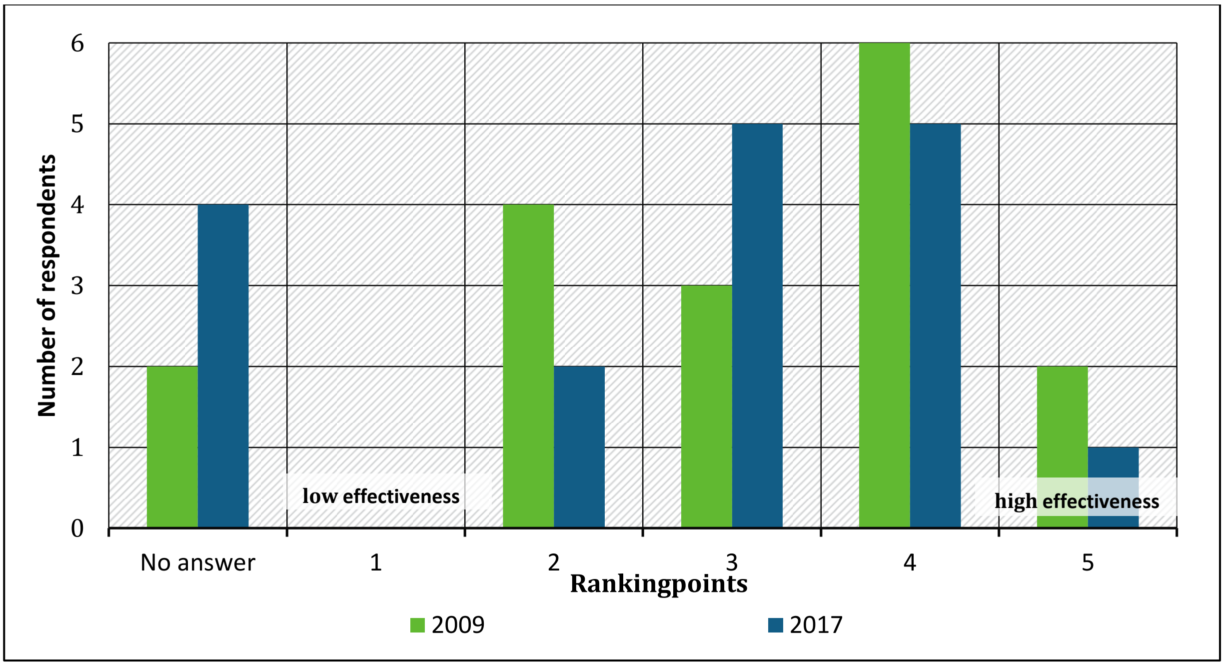
The system and structure of the TRAS describes the operator's obligation within safety management by conducting an adequate hazard source analysis, in which the kind, intensity and frequency of hazard sources (here floods and heavy precipitation) that a site might be susceptible to is analysed, as well as if major accidents can be triggered by the affection of safety relevant parts of the installation through such hazards. Further, a protection concept must be drawn and measures to prevent major accidents must be detected and implemented. In order to mitigate the effects of major accidents that may occur despite precautions, mitigation measures to be taken in such event must be specified.

To adapt to climate changing conditions, a factor of 1.2 must be applied to the intensities of flood and precipitation events in the risk assessment for establishments that are planned to be operated in 2050 and beyond.

### 3.1.2 Effectiveness of Regulations

As mentioned in the results of the survey in 2009 "survey participants [were asked] if they thought that their country's approach to chemical-accident prevention and natural-disaster management had been effective in preventing Natech accidents. Their opinion had to be ranked on a scale from 1 (low effectiveness) to 5 (highly effective)" and (N) representing the respondents that didn't reply to the question (Krausmann 2009).

**Figure 2: Self-estimated Effectiveness of Regulation in Preventing Natech Accidents in 2009 and 2017 (Question 2a)**

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As seen in figure 2, in 2017, 13 participants (76%) provided an answer to this question (question 2a), revealing that six (37.5%) respondents considered their countries' policies and practices in preventing Natech accidents as effective to highly effective. In 2009, eight respondents (thus, 47%) had the same opinion. This results in a slight decrease in the perception of specialists looking at the effectiveness of regulations to chemical-accident prevention and natural-disaster management in a timeframe of eight years. However, such changes in the perception of effectiveness may also be attributed to the differences in the sample of countries/institutions that have replied to the survey or even to the fact that the perception of stakeholders towards Natech risks prevention might be different since the last survey.

Under the question if any gaps or shortcomings in the country's rules or codes should be addressed to ensure effective Natech risk reduction (question 2b) 47% of the respondents replied affirmatively.

France and United Kingdom, for example, estimated that European regulations (Seveso-Directive or other) should define more precisely the return period or frequency of events that should be taken into account for natural hazards such as earthquakes or floods. Germany mentions the necessity of guidelines such as a (i) guideline on the consideration of natural hazards in safety documents (Seveso-Directive: safety reports) and emergency plans of operators and (ii) a guideline on the consideration of natural hazards in inspecting establishments according to the Seveso-Directive.

It can be noted that the gaps and shortcomings have become more specific compared to the results in 2009 where respondents mention issues such as (i) implementation and enforcement of specific regulations for Natech risk reduction, (ii) preparation of guidelines for industry and specific technical codes that address Natech risk, (iii) the development of methods for Natech risk assessment, (iv) land-use planning that explicitly addresses Natech risk, (v) better preparedness and training for the mitigation phase, as well as (vi) the development of best practices for Natech risk reduction.

Furthermore, in 2017 only one respondent indicated that there was an amendment in their country's rules or codes considering the publication of the Natech Addendum to the OECD Guiding Principles (2c), whereas 65% of respondents answered in the affirmative to the question (2d) regarding an amendment in their country contemplating the requirement of the EU Seveso-III-Directive (2012/18/EU) to consider natural hazards in Safety Reports. These differential results suggest that the EU Seveso-III-Directive has a far greater compliance rate than the merely voluntary OECD Guiding Principles, but also, that the Seveso-III-Directive has been a necessary instrument, since most countries have not been fulfilling its obligations prior to its entry into force.

## 3.2 Natech Events Data Collection and Retrieval

### 3.2.1 Database or Records for Chemical Accidents

In 2017, 15 respondents (88%) mentioned a database that can be used to record and retrieve information on chemical accidents (question 3) while 14 of these gave further descriptions, provided the respective link to the database, or indicated a contact person. In addition, nine respondents (53%) replied positively to the question if this database can be used to identify and retrieve information on Natechs.

In 2009 on the other hand, 13 (76%) out of 17 respondents indicated they have databases for chemical accidents. With respect to maintaining a database specific for Natech accidents, 15 respondents replied in the negative. The Seveso III-Directive compliant solution was to suggest a database of chemical accident reports that included Natechs. Hence, policy makers at the EU level were of the opinion that it made little sense for the Member States to have a separate database for Natechs, which is why the 2017 survey did not investigate whether states have a database for Natechs specifically. It should however be mentioned here that it might be helpful to have a Natech-specific database - such as the e-Natech database of the JRC - since, in contrast to the Major Accident Reporting System (eMARS) database, it goes beyond covering only major chemical accidents and allows to learn from the complete scope of Natechs.

## 3.3 Natech Awareness and Risk Reduction

### 3.3.1 Statements on Natech Awareness and Risk Reduction

In order to assess the level of awareness and knowledge of Natech risk and risk reduction, the 2009 survey asked respondents to answer ten targeted questions by ranking their answers from 1 (Disagree strongly) to 5 (Agree strongly). Likewise, in 2017, nine similar questions were made in order to assess Natech awareness and risk reduction in the same rankings (question 4). Here, the survey deliberately asked for an opinion of the respondents and not for facts. The results can be drawn from figure 3.

**Figure 3: Agreement or Disagreement to a Set of Questions (Question 4 a-h) Regarding Natech Awareness and Risk Reduction Level from the Survey in 2017**

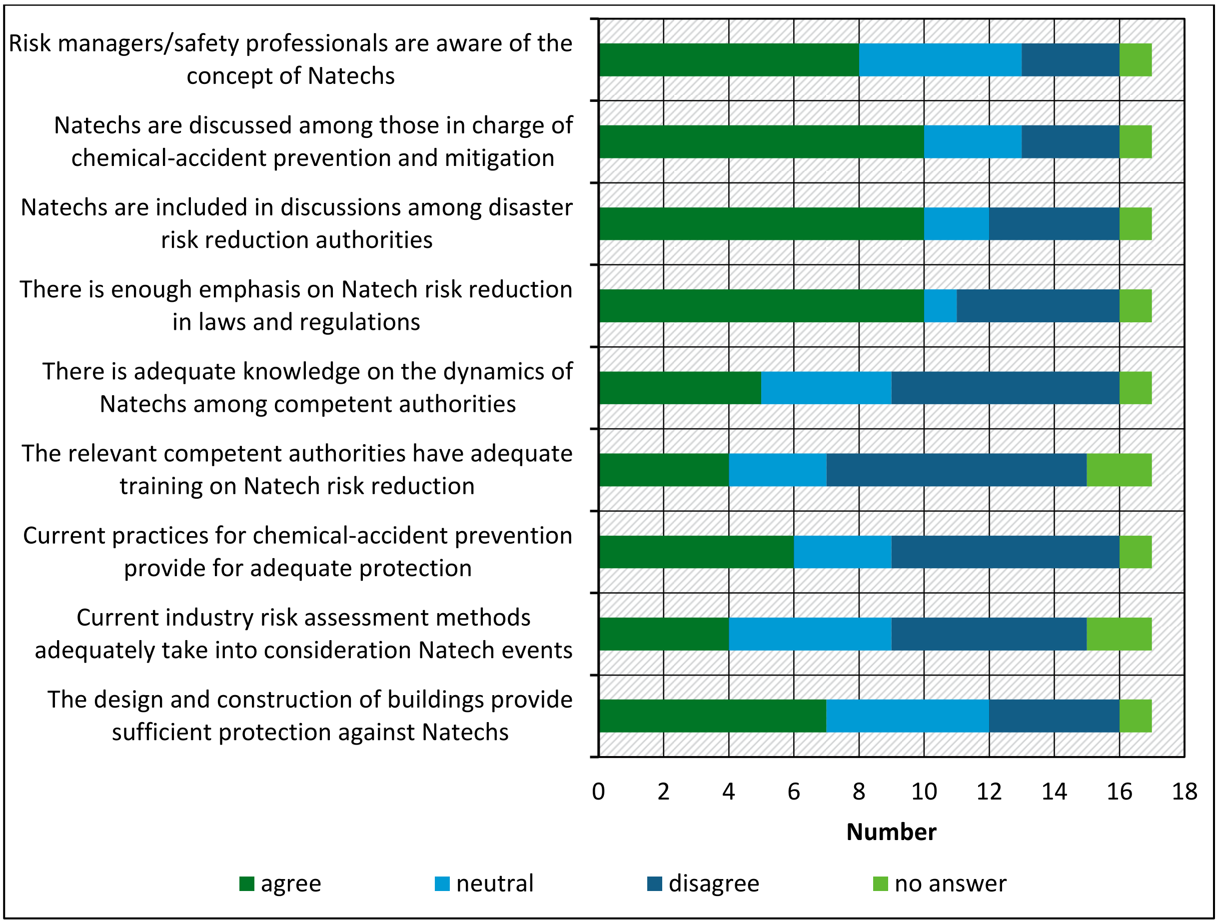


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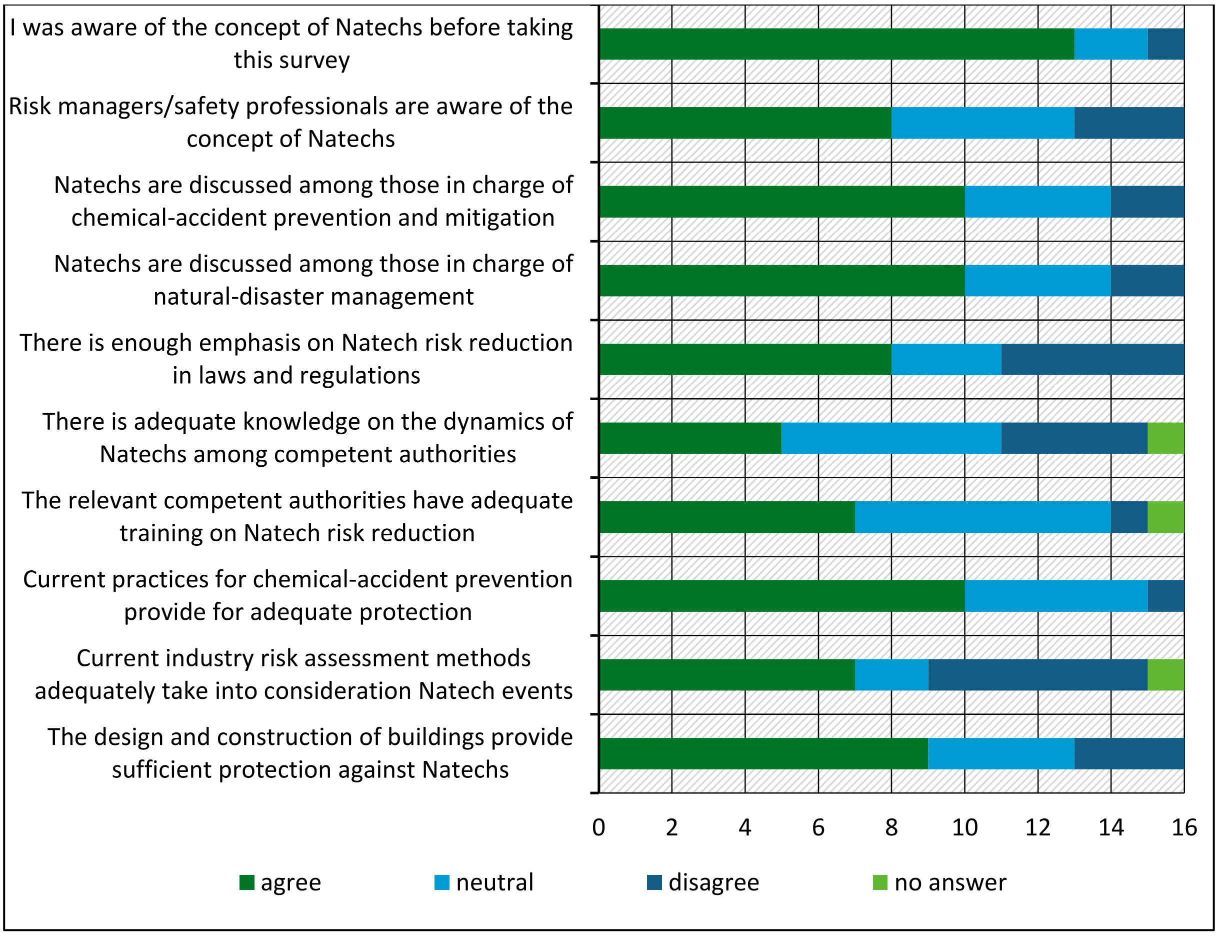
**Figure 4: Agreement or Disagreement to a Set of Questions Regarding Natech Awareness and Risk Reduction Level from the Survey in 2009**[5]

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[5] Here we are considering the 16 responses from competent authorities (CA) in the respective countries

**Figure 5: Agreement to the Statements on Natech Awareness and Risk Reduction Level in 2009 and in 2017**

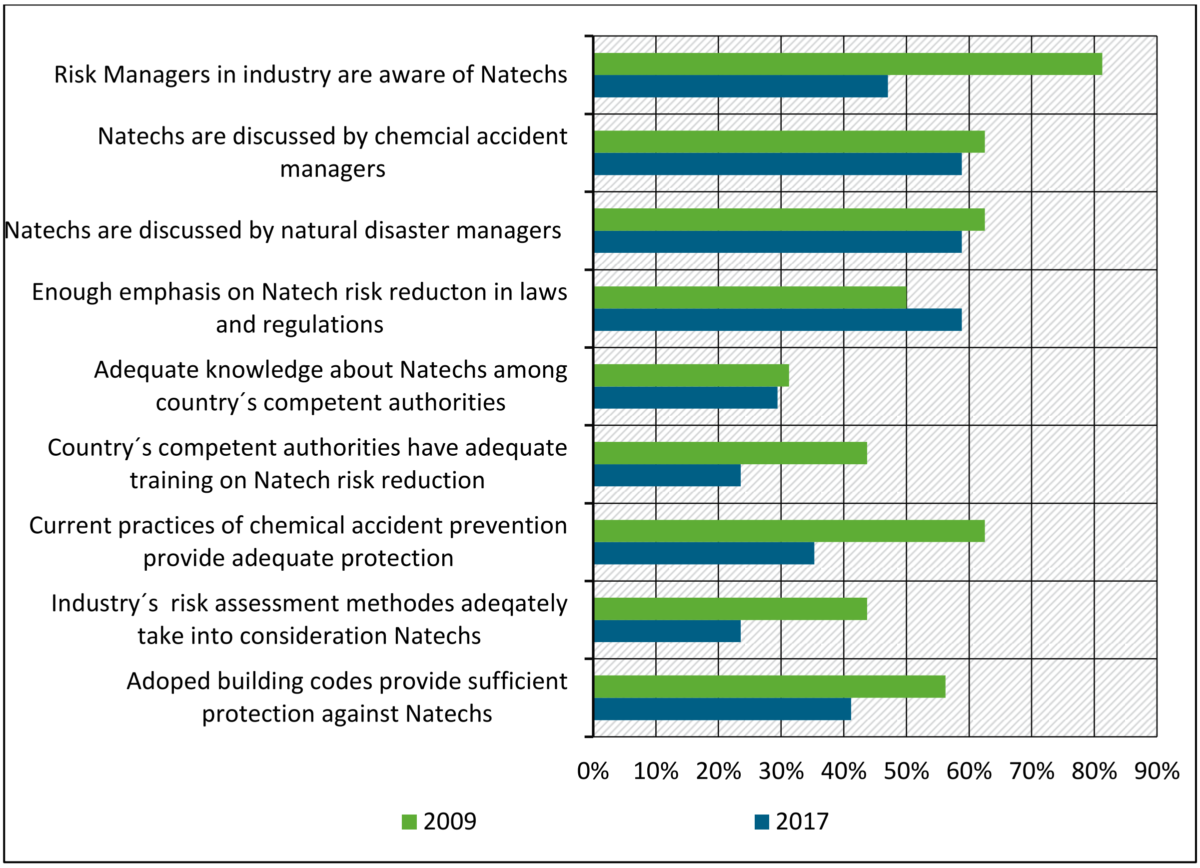


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Figure 5 shows that 50% or more of the respondents agree or strongly agree that:

1. (question 4a) industry risk managers/ safety professionals in their country/organization are aware of the concept of Natechs;
2. (question 4b) Natech events are discussed among those in charge of chemical-accident prevention and mitigation in their country/organization;
3. (question 4c) Natechs events are discussed among those in charge of natural-disaster management in their country; and
4. (question 4d) there is enough emphasis on Natech risk reduction in the laws and regulations for chemical-accident prevention and mitigation.

It can be stated that, in most of the cases, there is little difference between the results in the 2009 survey where 50% or more agreed on these hypotheses as well. However in question (4a) the difference in the answers between 2009 and 2017 is large. 30% more industry risk managers/ safety professionals in the countries/organizations were aware of the concept of Natechs in 2009 compared to 2017. The only question in which there was more awareness in 2017 is question 4d that points out emphasis on Natech risk reduction in the laws and regulations for chemical-accident prevention and mitigation.

On the other hand, there is less awareness concerning other questions. In 2017 more than 50% disagree or strongly disagree that:

1. (question 4e) there is adequate knowledge on the dynamics of Natechs among the country’s competent authorities;

2. (question 4f) the relevant competent authorities in the countries have adequate training on Natech risk reduction to enable effective Natech risk management;
3. (question 4g) current practices for chemical-accident prevention and mitigation in the countries/organizations provide for adequate protection of citizens against possible Natech events;
4. (question 4h) current industry risk assessment methods adequately take into consideration Natech events.

Lastly, under the question, if the design and construction of industry buildings and other structures provide sufficient protection against Natech accidents (question 4i), 24 % of respondents disagreed or strongly disagreed in 2017 with the comparison of 47% in 2009.[6] When looking more closely to the differences between the 2009 and 2017 survey in figure 5, it appears that there was more awareness on Natech risks in 2009 with differences of more than 20% in the questions 4e to 4i. Especially question 4g on current practices for chemical-accident prevention and mitigation in the countries/organizations that provide for adequate protection of citizens against possible Natech events shows a large difference in the eight years timeframe.

These results might indicate that awareness among respondents of the characteristics and risks of Natechs has risen and so self-estimation of protection level is considered lower. Yet, it should be again noted, that not the same countries answered in the 2009 and 2017 survey and therefore the results are not fully comparative in a quantitative manner.

### 3.3.2 Recommendations on Natech Risk Reduction

The survey asked the participants to indicate their top three recommendations in order to further reduce their country's or organization's susceptibility to Natechs. In 2017, 71% of the surveyed respondents indicated specific Natech risk reduction strategies/recommendations. Eight years earlier in 2009 also a high 77% of respondents indicated specific measures. Raising awareness on Natech risk at all authority levels, as well as in industry, and improving risk communication were mentioned by the majority of respondents as a crucial Natech risk reduction strategy in 2009.

Considering examples of Natech risk reduction strategies/recommendations, the following seem particularly relevant in 2017:

1. **Natural Hazards in Risk Analysis**: Four out of 12 respondents mentioned recommendations related to natural hazard risk assessments. New Zealand recommends the consideration of Natechs in the risk assessment of major hazard facilities conducted by the operator of the facility. Further, Colombia would advise the development of guidelines for Natech risk analysis and the learning from Natech risk analysis experiences.

2. **Natech Awareness and Risk Reduction:** Recommendations on Natech awareness and risk reduction were also made by four out of 12 respondents. One example given by United Kingdom is the improvement of general awareness of Natech initiators and their impacts. Additionally, Sweden proposes to increase the exchange of ideas and knowledge between the natural hazard and the major chemical accidents competence areas and use this competence further in the permitting process.

[6] In 2017, 29% responded neutrally.

## 3.4 Consideration of Natural Hazards and Natech Risks

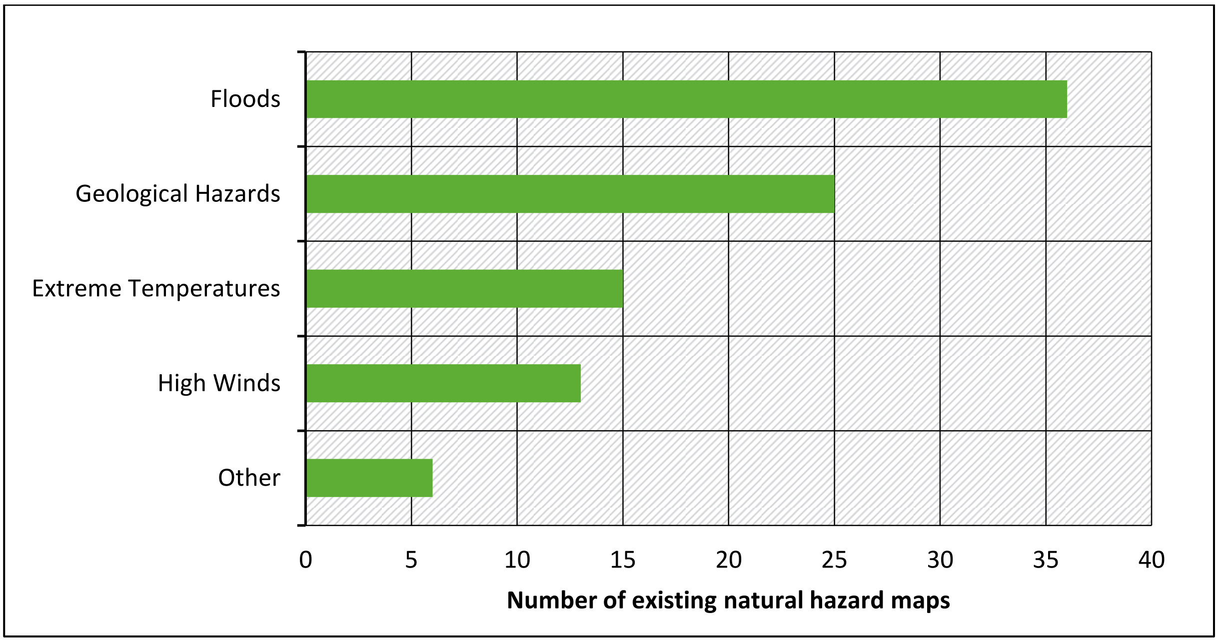
### 3.4.1 Natural Hazard Mapping and Early Warning Systems

As mentioned earlier, the respondents make use of natural hazard maps and early warning systems (question 6a, 7a). Additionally, it would be interesting to identify based on the results of this survey if these early warning systems trigger any kind of Natech risk management action. One indicator of a positive answer to this question might be that 13 respondents indicated that operators made use of early warning systems for their emergency management (question 7f).

Besides, the information on natural hazard mapping integrated in the following figure 6 and figure 7 (questions 6b, 6c, 6d) explain which types of hazards are mentioned, which scope they cover (national, regional, local) and if there are operators of hazardous installations involved in the drafting and amendment.

The natural hazard maps (question 6b) in the mentioned countries consider different hazards such as geological & seismic hazards (earthquake, mining-based or volcanic threats, mass movements, avalanches, tsunamis) and hydro- and meteorological hazards (floods, winds, typhoons, high tides, snow load).

**Figure 6: Consideration of Natural Hazards in Mapping**

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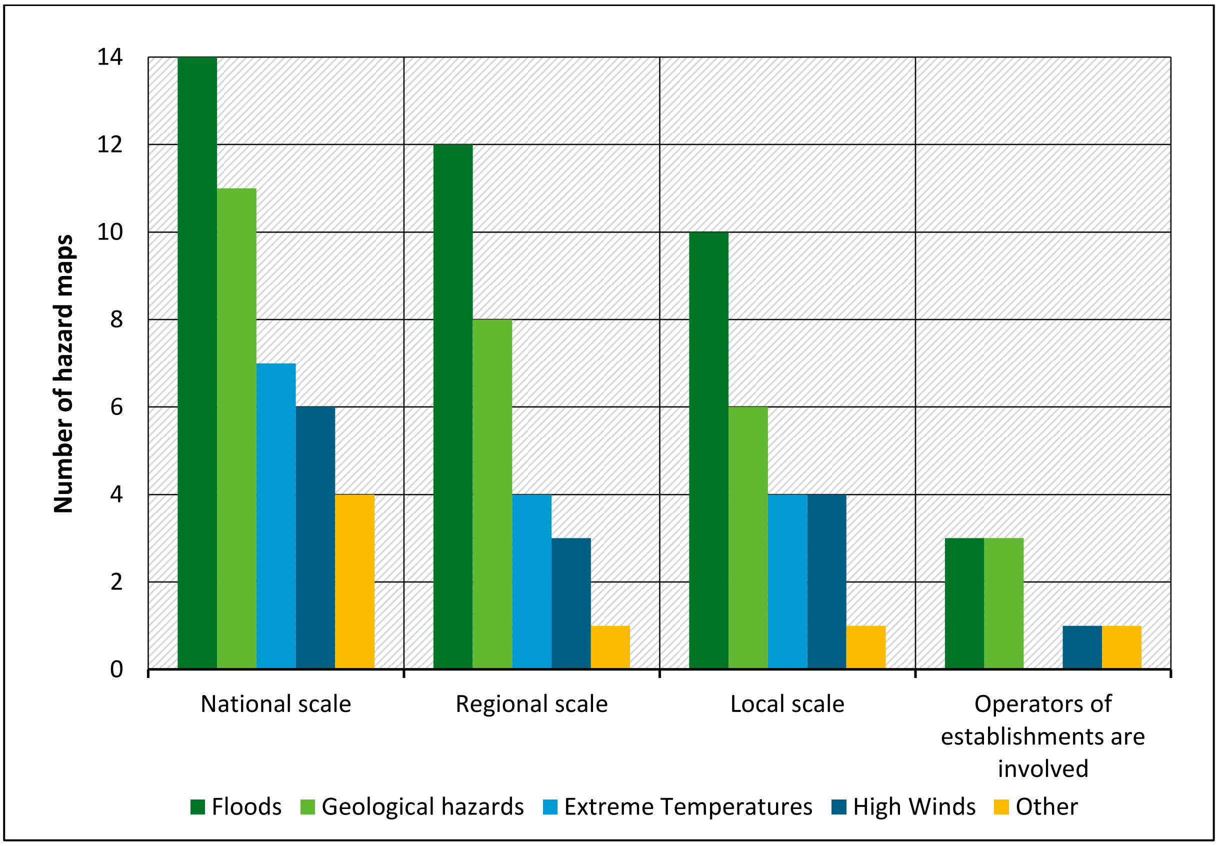
As seen in figure 6, floods are the most commonly mapped hazard. This might be related to the EU Floods Directive[7] (2007/60/EC) that entered into force in 2007, and that probably, from an historic perspective, flood maps have been the first hazard maps drafted. Based on the EU Floods Directive countries of the EU must develop flood hazard maps and flood risk maps for risk areas by 2013. The Directive applies to all kinds of floods (river, lakes, flash floods, urban floods, coastal floods, including storm surges and tsunamis), on all of the EU territory. Geological hazards are the second most relevant hazards to be mapped. At the EU level earthquakes and tsunamis seem to be the most relevant ones, but there are no specific directives in place. It should be

[7] http://ec.europa.eu/environment/water/flood_risk/implem.htm

noted here that there is a probability that the maps that were indicated by countries and institutions do not cover all kinds of geological hazards in one map. Instead the maps are expected to cover e.g. only earthquakes, but not avalanches or mass movements, leaving room for improvement of such hazard maps. There are twelve good practice examples indicated for natural hazard mapping by the participating countries. Seven of them focus only on one natural hazard risk (especially on flooding; five out of seven), while the four others are multi hazard maps illustrating several natural hazards (e.g. flooding, earthquakes, avalanches, tsunamis) in one map.

Finally, figure 7 shows a trend in the number of natural hazard maps, while a larger number of maps are available at the national level and a lower number at the regional and local level. Only very few of these maps involve operators of establishments directly during the drafting or amendment of these maps.

**Figure 7: Information on Natural Hazard Mapping**

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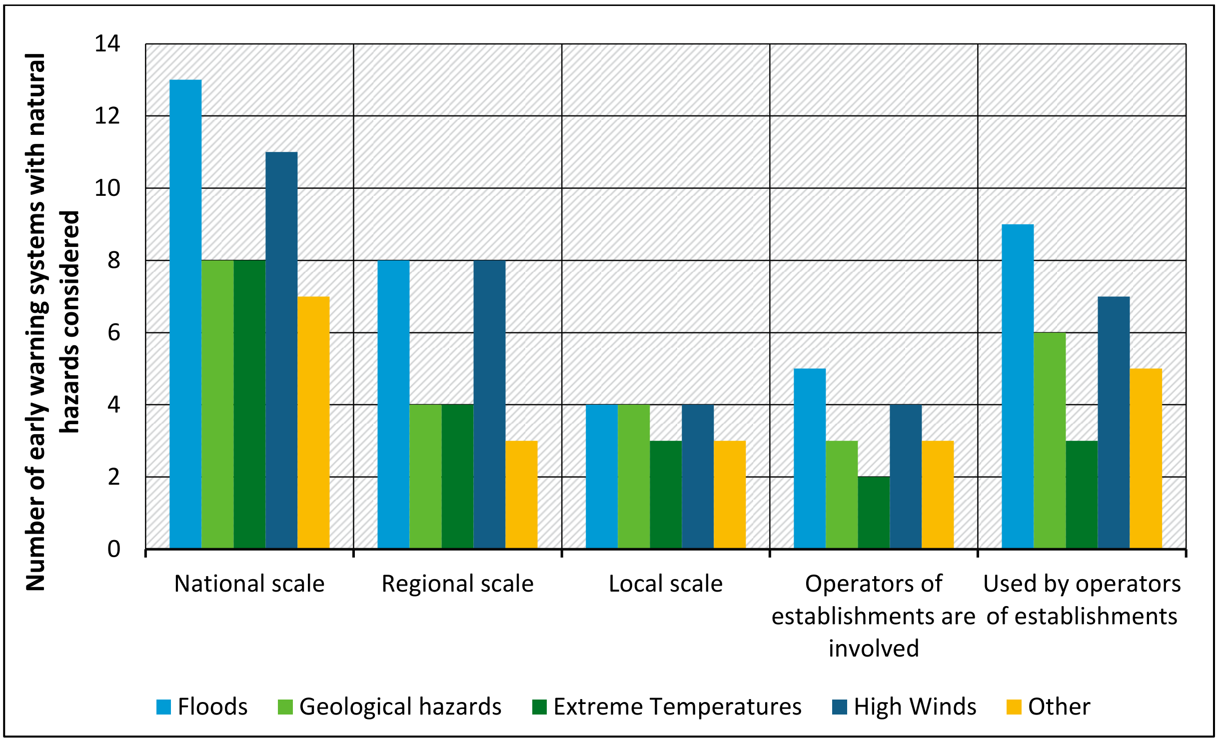
**Good Practice Example: Interactive Flood Risk Map (Saxony-Anhalt, Germany)**

The Ministry of water protection and water management of Saxony-Anhalt (Germany) runs an interactive flood map showing flood risk of high, medium and low probability. Unlike other flood risk maps, next to information about population, conservation areas and land use, the map also provides the location of risk sources like installations that fall under the EU-directive on industrial emission (2010/75/EU, IED) (replacing the EU-directive for Integrated Pollution Prevention and Control (2008/1/EC, IPPC). Furthermore, objects that have the need for special protection concern like UNESCO heritages or swimming waters are illustrated as well.

In figure 8 on natural hazard early warning systems, similar patterns can be identified as in figure 7 on natural hazard mapping with a decreasing number of early warning systems towards smaller scales. It appears though that operators of establishments are involved more often in early warning systems than in the drafting of natural hazard maps (17 compared to eight). The question, if operators of hazardous installations use these early warning systems for their emergency management (question 7f) was answered positively for the four main hazards (geological hazards, high winds, floods and extreme temperatures) but also for other hazards.

**Figure 8: Information on Natural Hazard Early Warning Systems**

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The survey in 2009 asked the countries directly if they had developed Natech risk maps. The replies showed that "while many countries have natural hazard/risk maps for some natural hazards, hardly any of them have specific Natech risk maps. Where these Natech risk maps exist they are usually a simple overlaying of natural and technological hazard maps. While this gives an indication of possible Natech hot spots it may not allow a realistic assessment of the Natech risk. The conclusion from this question would, therefore, have to be that there is a lack of Natech-specific risk maps in the responding OECD countries."(Krausmann 2009) Nevertheless, a lot of Natech risks (due to risks of "chemical" accidents) may be included in general „Chemical Accident risk maps".

**Good Practice Example: Public Warning and Information System via mobile phones (Lithuania)**

The Public Warning and Information System (PWIS) was installed by the Fire and Rescue Department under the Ministry of the Interior of the Republic of Lithuania. Its purpose is to alert residents and visitors to the Lithuanian territory in real time about dangerous situations by using cell broadcasting technology in mobile networks. Advantages of this technique are its very high level of reach because of full GSM (Global System for Mobile Communication) coverage in the country and a very high level of mobile phone usage by inhabitants. Additionally, people can be provided directly with useful information about the level of risk, behaviour recommendations and how to avoid the hazard zone. Furthermore, the PWIS can be used for preventive message delivery to inform about potential dangers. (Lithuanian Fire and Rescue Department 2014)

### 3.4.2 International Cooperation in Mapping and Early Warning Systems

In the newly adopted "Sendai Framework for Disaster Risk Reduction 2015-2030" at the Third UN World Conference, "the scope of disaster risk reduction has been broadened significantly to focus on both natural and man-made hazards and related environmental, technological and biological hazards and risks" (UNISDR 2015). This demonstrates that the international disaster risk reduction community is considering Natechs in its most relevant agreement. It should be emphasized that transboundary cooperation in the context of natural hazards is especially relevant. Since natural hazards do not respect national borders, it may make sense to draw up or at least coordinate hazard maps across borders, e.g. flood hazard maps or flood warning systems for river basins.

The results of the survey show that, international cooperation on both natural hazard maps and early warning systems could be enhanced, though. Under the question (8a, 8b), if there is transboundary or international co-operation in the development of natural hazard maps and natural early warning systems, only 53% (hazard maps) and 41% (early warning systems) of respondents respectively replied positively to this question.

1. **Natural hazard maps:** The Sendai Framework for Disaster Risk Reduction (UNISDR 2015) promotes the development of periodically updated location-based disaster risk information, including risk maps. Concerning natural hazard maps, Colombia for example cooperates with Japan on a project for the application of State of the Art Technologies to Strengthen Research and Response to Seismic, Volcanic, and Tsunami Events and with the United States Geological Survey to improve monitoring of volcanos. Finland collaborates with the other Baltic Sea States through HELCOM and Environmental and Rescue authorities. France works on maps for industrial risks with Germany.
2. **Early warning systems:** One of the goals of the Sendai Framework of Disaster Risk Reduction is to "substantially increase the availability of and access to multi-hazard early warning systems by 2030" (UNISDR 2015). Japan, for example works with Indonesia and Myanmar in early warning systems (e.g. for tsunamis). In Lithuania, the Fire and Rescue Department (FRD) established the Situations Coordination Division for the Transboundary Effects of Industrial Accidents. The Division transfers information on emergency situation to/from coordination centres of neighbouring countries, NATO EADRCC, UN OCHA and EC ERCC. Also Lithuanian Hydrometeorological Service under the Ministry of Environment is a member of Meteoalarm (for meteorological events) and EFAS (for hydrological events).

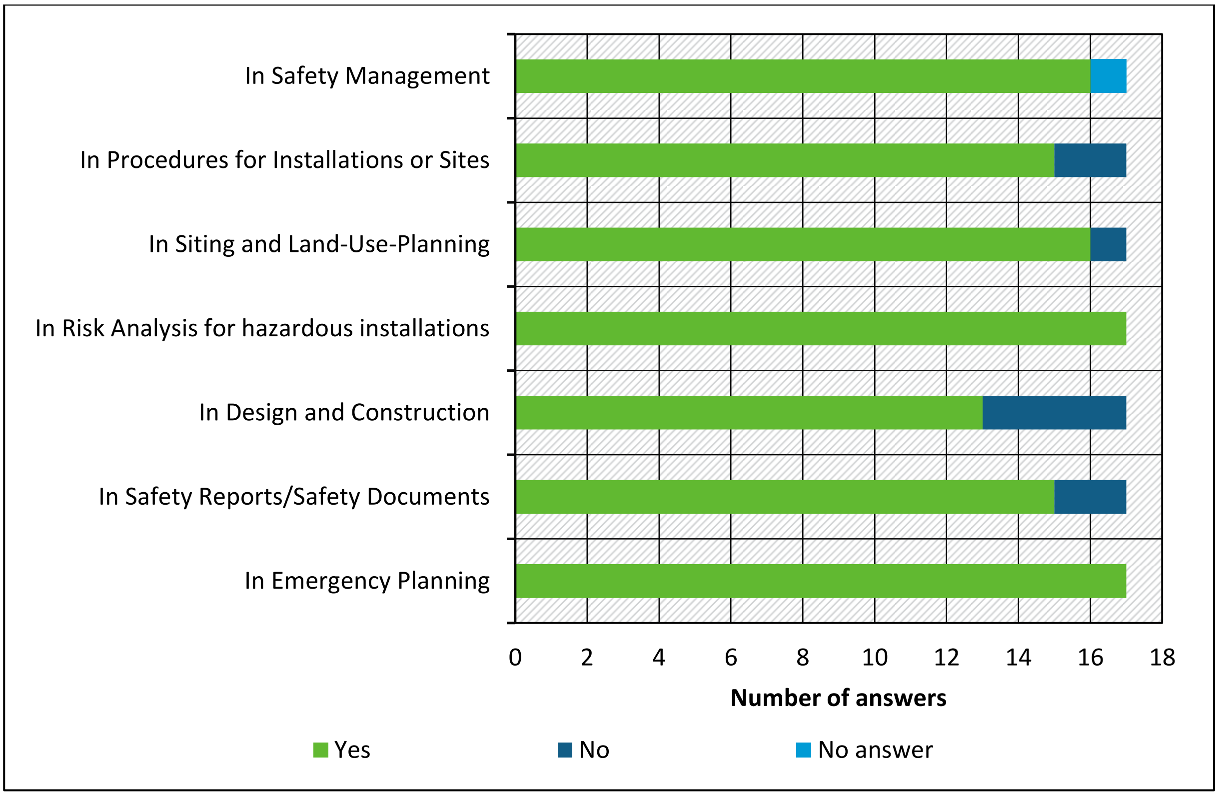
**Good Practice Example: The Global Framework for Climate Services**

The Global Framework for Climate Services is a global partnership of governments and organizations. It aims at the incorporation of researchers, producers and users of climate services like forecasts and climate change scenarios to increase both quantity and quality of climate information worldwide, especially for developing countries. To achieve this, an active exchange of good-quality data from national and international databases of climate parameters as well as long-term historical average data is pursued. (GFCS n.d.)

### 3.4.3 Consideration of Natural Hazards in Safety Management,

This includes consideration in (operating) procedures for installations or sites, in siting and land-use-planning, in risk analysis, in design and construction, in safety reports / safety documents, and in emergency plans.

**Figure 9: Information on Consideration of Natural Hazards in Different Risk Management Components (Questions 9a, 10a, 11a, 12a, 13a, 14a, 15a, 16a)**

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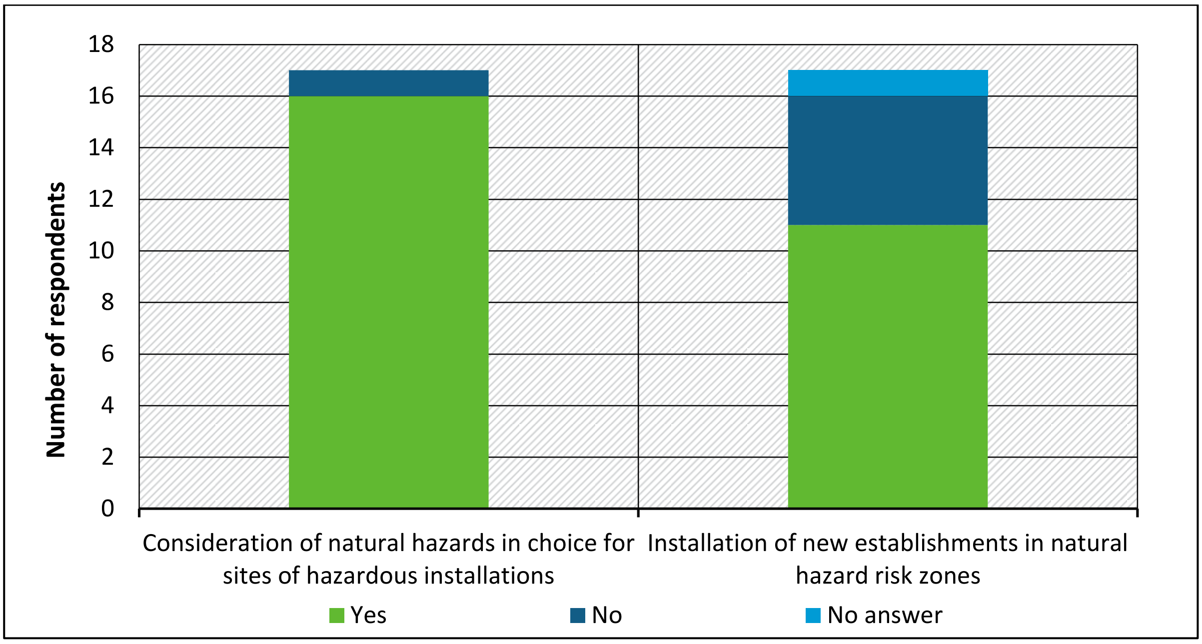
As can be drawn from figure 9, most of the respondents agree that natural hazards are taken into consideration in all the mentioned risk management issues.

1. **Safety Management at hazardous installations:** As can be seen in figure 9, 94% of respondents consider that natural hazards are taken into consideration in safety management at hazardous installations (question 9a). However, only 47 % reported these as good practices in Natech Risk Management (question 9b).
2. **(Operating) procedures for installations or sites:** Natural hazards are considered in operating procedures in 88% of the cases (question 10a). Special operating procedures for impacts of natural hazards exist in 71% of the cases (question 10b). Nevertheless only 29% think that these procedures can be a good practice in Natech Risk Management. The high number of positive replies might indicate that only those states already aware and/or active in the field of Natech Risk Management responded to the survey. Had states with lower levels of awareness responded to the survey, the results might thus have been rather differential.

**Figure 10: Consideration of Natural Hazards in Choice for Sites of Hazardous Installations (Question 11a) and Consideration of New Installations Sites in Natural Hazards Risk Areas (Question 11b)**

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3. **Siting and land-use-planning:** Figure 10 shows that almost all respondents state that natural hazards are considered in the choice of sites or in land-use-planning of areas for new hazardous installations (question 11a). 65% of respondents affirm that new installations sites are considered in natural hazards risk areas (questions 11b). In this case only 18% of the respondents consider having a good practice in terms of evaluations or analyses in Natech Risk Management regarding siting and land-use-planning (question 11c).
4. **Risk analysis for hazardous installations:** Natural hazards in risk analysis for hazardous installations are widely considered in the responding countries (question 12a). Furthermore, 59% of the respondents agree on the fact that Natech risks are taken into account in the mapping of risks identified by this analysis (questions 12b).
5. **Design and construction:** In 76% of the cases, natural hazards are considered in the design and construction of hazardous installations. Nevertheless only 29% of respondents were able to list technical codes or standards that could be the basis of this consideration (questions 13a). Under the question if one of these procedures, codes or standards could be a good practice in Natech Risk Management, 24% replied in the affirmative (question 13c).
6. **Safety reports / safety documents:** Figure 9 shows that 88% of the respondents consider natural hazards in safety reporting or documentation. Furthermore, it can be drawn from figure 12 that “presentation of the environment of the establishment“ and „identification and accidental risks analysis and prevention methods“ are categories in safety reports or documents where natural hazards are most commonly mentioned (question 14a). However, only 24% of the respondents could provide good practice examples based on safety reports/documents in Natech Risk Management (question 14b).

7. **Emergency plans:** All respondents agree that natural hazards are considered in the drafting of emergency plans for hazardous sites or installations (question 15a), but only two (Germany and United Kingdom) are submitting good practice examples regarding this issue (question 15b).

As seen in figure 11, though many of the respondents consider natural hazards as an important factor to involve in risk management, they do not name a good practice example in their country, which indicates room for improvement in the consideration of Natechs.

**Figure 11: Specification on a Good Practice Example Considering Natural Hazards in the Following Fields**

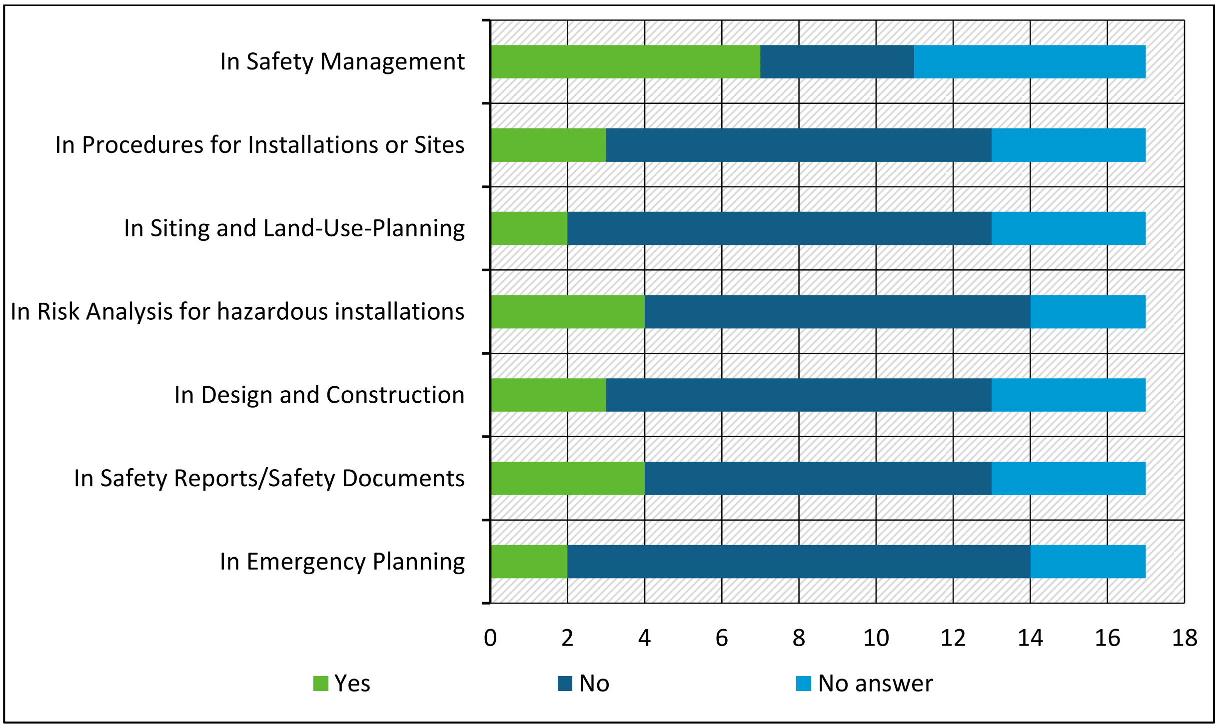


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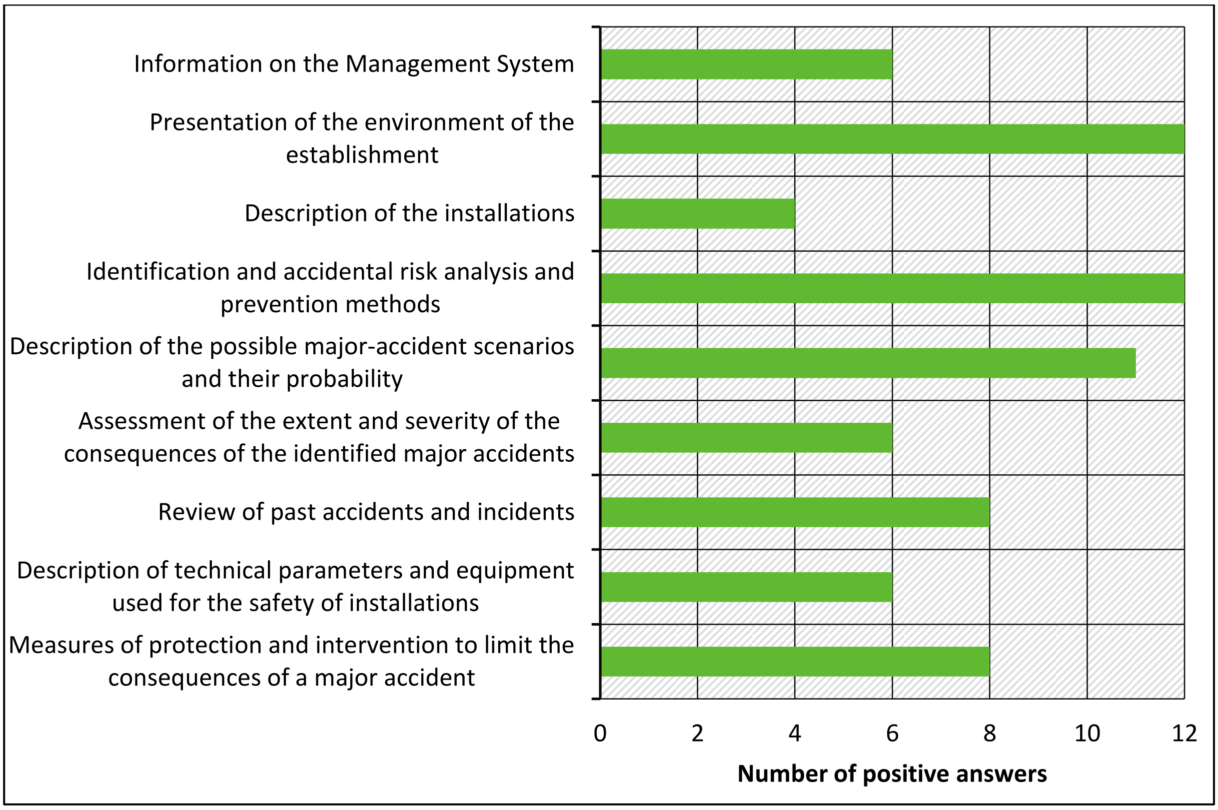
**Figure 12: Consideration of Natural Hazards in Safety Reports/Documents (Question 14a)**

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From figure 12, it is noticeable that natural hazards are considered more frequently in the description of the environment and at the beginning of the risk analysis than in the accident scenarios actually considered further and the definition of measures to limit their effects. Again, it might be that the survey was answered by those countries that are already active in Natech Risk Management, while other countries chose not to reply.

**Good Practice Example: Planning Policy Statement 25 (PPS): Development and Flood Risk (UK)**

The Department for Communities and Local Governments, UK, published the Practice Guide Development and Flood Risk in 2008 (update followed in 2009) to supplement the Planning Policy Statement 25 (PPS25) which intends to set out policy on development and flood risk. The guide aims at taking into full account flood risk at all planning levels and how to implement this approach since planning has a key role to play in avoiding and reducing the risk from floods. The approach it adopts to do so is summarized best in the hierarchy: assess – avoid – substitute – control – mitigate. As to perform long-term planning, climate change impacts must be included in flood risk assessments. (PPS25 2009)

### 3.4.4 Consideration of the Effects of Climate Change & Natechs and Climate Change in Licensing

Questions regarding effects of climate change were not raised in the 2009 survey. Due to increasing international interest in climate change issues, this topic has become more prominent along recent years and is being mainstreamed into the disaster risk management community. The Intergovernmental Panel on Climate Change (IPCC) report “Managing the risks of extreme events and disasters to advance climate change adaptation”(IPCC 2012) from 2012 mentions

Natechs in particular when referring to the importance of knowledge in issues such as: “How climate change affects hazards, particularly regarding processes by which human activities in the natural environment or changes in socio-ecological systems lead to the creation of new hazards (e.g., **Natech hazards**), irreversible changes, or increasing probabilities of hazard events occurrence”.

Climate change is indeed being considered in natural disaster risk management by some countries. To the question, if effects of climate change are being taken into account in the risk analysis for hazardous installations 53% of the respondents gave a positive answer (question 16a), though only 18% acknowledged these analysis as good practice examples in Natech Risk Management and 12% submitted a copy or provided links to relevant documents of good practice examples (question 16b). Lastly, to the question if risk analyses or emergency plans are reviewed and updated – if necessary – to consider climate change, 53% had a positive answer (question 16c). It might be that risk analysis for hazardous installations with the inclusion of effects of climate change on natural hazards are still under development as standardised approaches and methodologies for climate change risk assessments evolve.

Along with this question on climate change consideration, the survey raised the question if Natech risks or climate change were considered in the licensing of hazardous installations. 53% of the respondents answered positively (question 17a). However, in total, only 24% (France, Germany, Sweden, United Kingdom) of the respondents were able to provide documentation on regulations or specific guidance to this issue (question 17a). And again, only 12% provided good practice examples of these regulations or guidance (question 17b).

### 3.4.5 Natechs in Inspections Systems and Inspections and Natech Risks at Existing Installations / Sites

**Natechs in inspections systems and inspections:** From the answers to question 18a it results that Natechs in Inspection Systems and Inspection are widely taken into account (88%). Nevertheless, only four respondents (Germany, Japan, Poland, and Lithuania) are doing so on the basis of regulations or specific guidance. Under the question if these inspection systems or plans, regulations or guidance could be a good practice in Natech Risk Management only 29% of the respondents gave a positive answer (question 18b).

**Good Practice Example: Common Inspections Criteria for Natech**

The European Commission's Technical Working Group on Seveso II Inspections (TWG2) has launched the preparation of Common Inspections Criteria for Natech. This guidance document for inspectors with a specific focus on Natech risks will be produced by the European Commission's Joint Research Centre (lead) with representatives of the EU Member States. The Common Inspections Criteria are expected to be released within 18-24 months after the start of the activity.

**Natech risks at existing installations/ sites:** 88% of the respondents agree that Natech Risks are considered at existing sites or installations (question 19a). Furthermore, 24% of the respondents think that regulations or guidance in their country regarding Natech risks at existing installations/ sites can be a good practice example and 18% could actually submit an example (question 19b). However, these numbers cannot lead to any conclusions about the detail/extent to which Natechs are considered at existing sites or installations, and hence the quality of the considerations. Something remarkable is that 53% agree to have any experience with retrofitting of installations to design requirements or to increased design requirements due to natural hazards (question 19c). But only four respondents could submit a copy of or provide links to relevant documents (France, Germany, Poland, and Norway).

### 3.4.6 Natech Risks in Risk Communication

The “2018 Understanding Risk Forum” organized by the World Bank that took place in Mexico City had a focus on risk communication and perception. It is a global community of experts and practitioners in the field of disaster risk identification, specifically risk assessment and risk communication. In both climate change and disaster risk management scientific and practitioner communities, this is a topic that has been gaining importance.

According to the 2009 survey, the top Natech risk reduction strategies are:

1. Raising awareness at the government and industry levels and improving risk communication among others, as well as;
2. Improvement and integration of natural and technological risk maps; and
3. Improvement of existing regulations and development of specific guidelines by means of good practice examples.

These results indicated the need to put the government and the private sector together in order to improve Natech risk reduction strategies, to continue working on risk map methodologies and to collect good practice examples from countries experiences with Natechs.

However in 2017, only 35% of the respondents agree that:

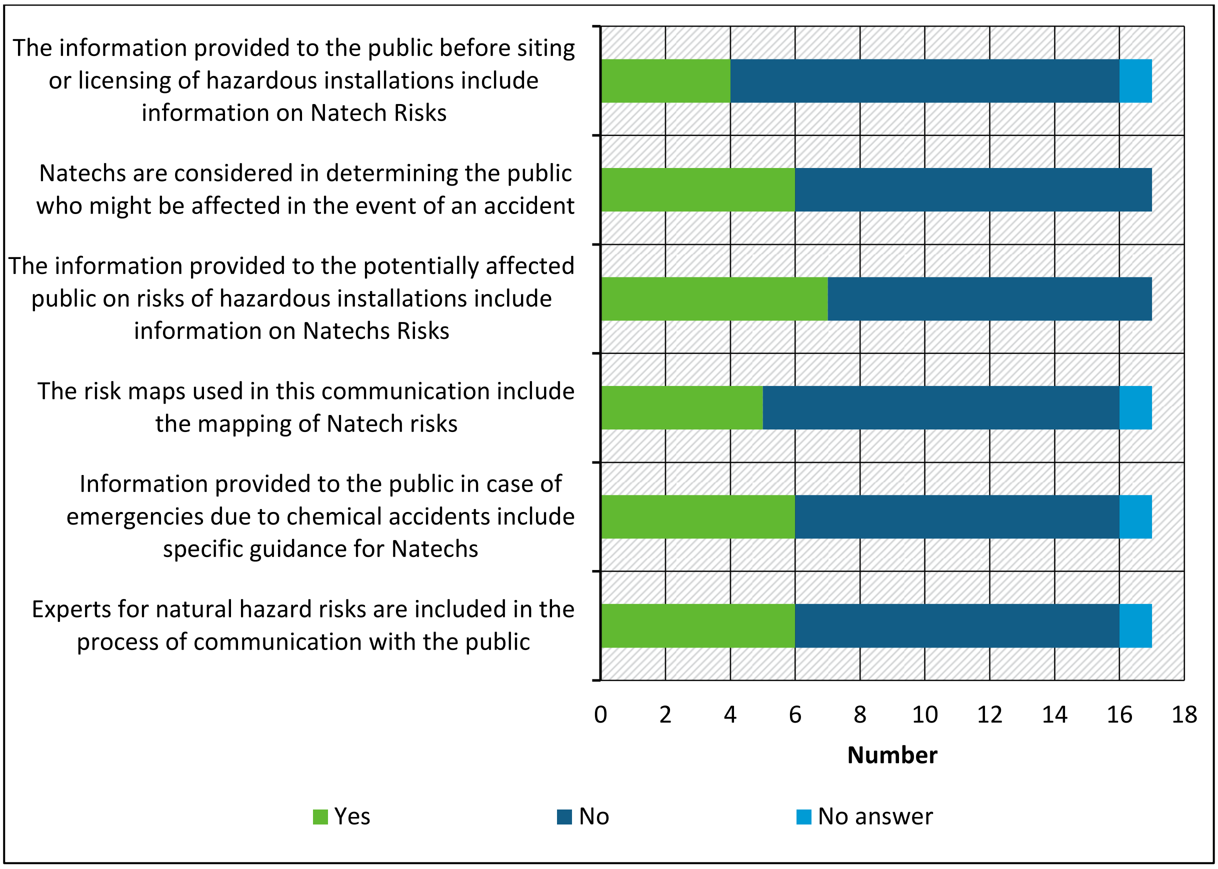
1. Information provided to the potentially affected public in case of emergencies due to chemical accidents includes specific guidance for Natechs, if Natech risks are relevant (question 20e); and
2. Information provided to the potentially affected public on risks of hazardous installations includes information on Natechs Risks, if relevant (question 20c).

While experts for natural hazard risks are included in the process of communication with the public, if Natech risks are relevant in 41% of the answers (question 20f).

Finally, only 24% replied that information provided to the public before siting or licensing of hazardous installations includes information on Natech Risks (question 20a).

All these results demonstrate the low visibility of Natech events in the risk communication systems put in place in the countries.

**Figure 13: Consideration of Natech Risks in Risk Communication**



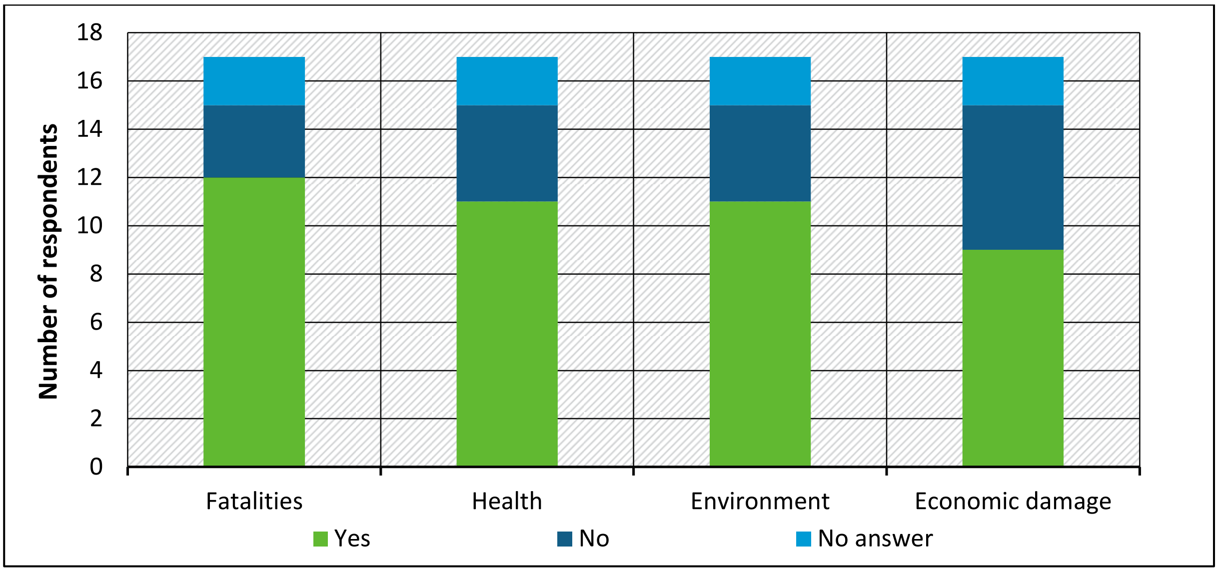

Own graph, adelphi research gGmbH

### 3.4.7 Natechs in Follow-Up of Natural Disasters

The survey in 2017 shows that Natech accidents are reported in cases of natural disasters in 82% of the cases (question 21a). One common problem in this kind of reporting is that other natural hazard effects are frequently more relevant and consequently it is not given much importance to Natech.

The figure 14 shows which information on effects of these Natechs is included in these reports. The most common impacts are fatalities, followed by health and environmental issues and economic damages (question 21b).

**Figure 14: Effects of Natechs Reported in Case of Natural Disasters Reports (question 21b)**




Own graph, adelphi research gGmbH

Question 21c asks the respondents if there is an analysis of the causes of and lessons to be learnt from these Natechs and which authority/authorities collects the results of the analysis, 47% and 41% respectively replied in the affirmative to this questions.

### 3.4.8 Natechs in Education and Training

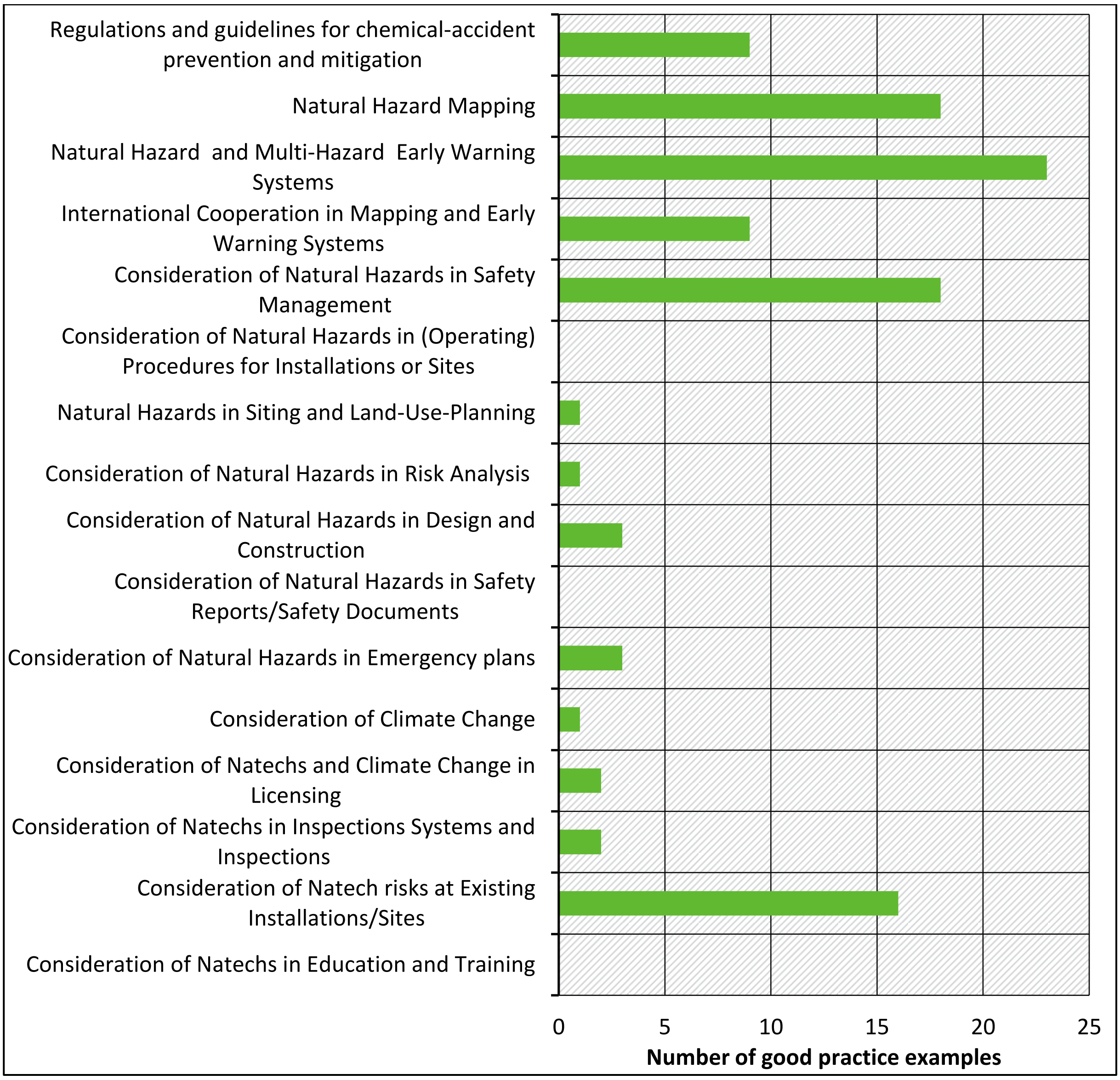
In 2017, 59% of respondents mention that Natech Risks are considered in education or training of persons in charge of the safety of hazardous installations (question 22a). This result is not so bad when one considers the little percentages that can be drawn from the Natech risk communication questions. Furthermore, a 71% of respondents mentioned that Natech risks are considered in education or training of persons in charge of disaster (risk) management (question 22b). This might be interpreted as an effort in Natechs education and training.

# 4 Main Conclusions from the Survey

## 4.1 Good Practices in Natech Risk Management

The survey asked for 16 possible areas in which examples of good practice in Natech risk management might be found. As seen in figure 15, there was wide variation in the replies, revealing that in some areas many responding countries have taken significant steps, while in others considerable work remains to be done.

**Figure 15: Number of Specifications on Good Practice Examples**




Own graph, adelphi research gGmbH

Most of the good practice examples were given in the fields that address general natural hazard issues like natural hazard maps, early warning systems and consideration of natural hazards in emergency plans. It has to be mentioned that for the categories 'consideration of natural hazards in safety management' and 'consideration of Natech risks at existing installations/sites', most of the examples were given by Lithuania (12 out of 18 and 13 out of 16). It can further be seen that questions, which asked for specifically Natech-concerning issues, the naming of good practice examples gets very low to no naming at all among respondents. When positive answers about existing good practice example were given, but no specification further indicated, the answers were not counted in the evaluation.

In general, the evaluation shows that there is still much room for improvement taking natural hazards and especially Natechs more into consideration among authorities of the participating countries, though improvement was made mainly in natural hazard identification and communication.

## 4.2 Consideration of Natech Risks in Regulations and Guidelines for Chemical-Accident Prevention and Mitigation

According to about 60% of the answers, rules, codes or guidance on Chemical Accident prevention or mitigation address natural hazards somehow. But only 30% of the answers can name documents specific for Natech Risk Management. Since 2009, the perception of respondents has decreased that the regulation of Natech risks is effective.

This indicates that Natech risks and Natech Risk Management are regulated in a lot of cases only on a general level. There may be a lack of guidance specific for Natech Risk Management and implementation of regulations on Natech risks.

## 4.3 Risk Management Practices and Awareness of Natechs

The results from both surveys in 2009 and in 2017 assert that general awareness and knowledge of Natech risk and risk reduction are in place. Data collection systems to inform about chemical accidents are established in most of the responding countries.

In 2017, more than half of the respondents agree that:

1. professionals are aware of the concept of Natechs;
2. Natech events are discussed among those in charge of chemical-accident prevention and mitigation and natural-disaster management; and
3. there is enough emphasis on Natech risk reduction in the laws and regulations for chemical-accident prevention and mitigation.

Nevertheless, more than half of the respondents also disagree that:

1. dynamics of Natechs among the country's competent authorities are adequately known;
2. competent authorities have adequate training on Natech risk reduction;
3. there are current practices for chemical-accident prevention and mitigation provide for adequate protection of citizens against possible Natech events in place;
4. current industry risk assessment methods adequately take into consideration Natech events; and
5. the design and construction of industry buildings and other structures provide sufficient protection against Natech accidents.

Except for the two questions on the discussion of Natech risks by "chemical accident managers" and on the emphasis on rules and regulations, the consent to the other questions decreased from 2009 to 2017.

This may be caused by an increased awareness of the risk characteristic of Natechs, which has led to lower self-estimation of protection levels by respondents.

## 4.4 Needs and/or Limitations in implementing Natech Risk Reduction Strategies

**Natural Hazard Mapping and Early Warning Systems:** There is a trend in the number of natural hazard maps and early warning systems. While a larger number of natural hazard maps and warning systems are available at the national level, a lower number is available at the regional and local level. Only in very few cases mapping or maps directly involve the operators of hazardous facilities. According to about 2/3 of the answers operators use warning systems, but these may be in a lot of cases the systems on the national level not systems on the local level addressing situations at the sites of hazardous facilities.

**International Cooperation in mapping and Early Warning Systems:** As the international disaster risk reduction community is considering Natechs in its most relevant agreement "Sendai Framework for Disaster Risk Reduction 2015-2030", the survey shows that international cooperation on both natural hazard maps and early warning systems could be enhanced, though. Nevertheless, countries such as Colombia, France, Germany, Lithuania and Japan gave some examples of good cooperation. Transboundary cooperation in the elaboration and implementation of hazard maps or warning systems, e.g. along riverine systems, is essential and should be promoted by international organizations.

**Consideration of Climate Change, consideration of Natechs and Climate Change in licensing:** Due to increasing research on climate change issues, it became clear, that intensity and frequency of several natural hazards will be influenced by climate change. Therefore climate change is indeed being considered in Natech and natural disaster risk management by some countries. However, it might be that risk analysis for hazardous installations with the inclusion of climate change influenced hazards are still under development as standardised approaches and methodologies for climate change risk assessments evolve.

**Natech risks in Safety Reports/Documents, emergency plans, and inspections:** According to 88% of the respondents natural hazards are considered in safety reports/documents and 25% of respondents recognize these safety reports/documents to be good practice examples in Natech Risk Management (question 14b). All respondents agree that natural hazards are considered in the drafting of emergency plans for hazardous sites or installations (question 15a), but only two are submitting good practice examples regarding this issue. According to 88% of the answers Natechs are widely taken into account in Inspection Systems and Inspections. Nevertheless, only three respondents are doing so on the basis of regulations or specific guidance. Under the question if these inspection systems, plans or guidance could be a good practice in Natech Risk Management only 29% of the respondents gave a positive answer.

**Natech risks in risk communication:** In 2017, only little more than one third of the respondents agree that:

1. Information is provided to the potentially affected public in case of emergencies due to chemical accidents that includes specific guidance for Natechs, if Natech risks are relevant;
2. Information is provided to the potentially affected public on risks of hazardous installations, including information on Natechs risks, if relevant;
3. Experts for natural hazard risks are included in the process of communication with the public, if Natech risks are relevant; and
4. Only 24% replied that information provided to the public before siting or licensing of hazardous installations includes information on Natech risks.

The 2017 survey results demonstrate the low visibility of Natech events in the risk communication systems put in place in the countries.

**Natechs in education and training:** Finally, Natech risks shall be widely considered in education or training of persons in charge of safety of hazardous installations and of disaster (risk) management. This might be interpreted as an effort in Natechs education and training.

## 4.5 Progress Since the First Survey in 2009 and Remaining Gaps

The publication in 2015 of an addendum to the OECD Guiding Principles on Chemical Accident Prevention, Preparedness and Response (OECD 2015) dealing specifically with Natechs has been one substantial milestone in the development of regulations for the prevention of Natechs.

The results of the survey show on the one hand a lack of efforts by OECD countries in terms of rules, codes and/or guidelines that specifically address natural hazards to which countries are especially vulnerable. On the other hand (i) a document providing guidelines specific to Natech risk management and (ii) strategies or programs to address the problem of Natech events are not widely available among the countries. The survey shows the necessity of OECD countries to continue working on this issue.

The self-estimated effectiveness of regulations for Natech accidents prevention has slightly decreased in a timeframe of eight years. This could be related to the fact that Natechs are increasingly being recognized as serious threats that require adequate risk management efforts and policymakers are more aware of this. However, such changes in the perception of effectiveness may also be attributed to the differences in the sample of countries/institutions that have replied to the survey. It can be noted as well that the gaps and shortcomings have become more specific and better defined when compared with the results in 2009.

# 5 Proposals for Further Improvement in Natech Risk Management from the Survey

From the conclusions drawn from needs and/or limitations for implementing Natech risk reduction strategies some recommendations can be made. These are specifically related to guidance on the consideration of Natechs in:

1. **Safety Reports/Safety Documents and Emergency Plans:** The results of the survey (questions 14 and 15) indicate that risk management stakeholders are expecting guidance for the consideration of Natechs in Safety Reports/Safety Documents and Emergency Plans. Natechs are widely considered in this kind of reports, documents and plans. Nevertheless, specific guidance on how to consider them is a gap that should be approached in order to improve Natech Risk Management.
2. **Inspections Systems and Inspections:** Regarding Inspection Systems and Inspections, the survey shows that Natechs are also widely taken into account, but regulations or specific guidance are lacking in the majority of the cases (questions 18). Answering to this gap, the European Commission's Technical Working Group II (TWG2) on Seveso-III-Inspections has launched the preparation of Common Inspections Criteria for Natech, a guidance document for inspectors with a specific focus on Natech risks.

Against examples of Natech risk reduction strategies/recommendations, the following seem particularly relevant in order to further reduce country's or organization's susceptibility to Natechs (question 5):

3. **Natural Hazards in Risk Analysis**: New Zealand recommends the consideration of Natechs in the risk assessment of major hazard facilities conducted by the operator of the facility. Further, Colombia would advise the development of guidelines for Natech risk analysis and the learning from experience from Natech risk analysis.

Natech Awareness and Risk Reduction: One example given by United Kingdom is the improvement of general awareness of Natech initiators and their impacts. Additionally, Sweden proposes to increase the exchange of ideas and knowledge between the natural hazard and the major chemical accidents competence areas and use this competence further in the permitting process.

# 6 Summary of the Current State of Research Based on the Contributions to the UN/OECD Natech II Workshop

The Workshop on Natech Risk Management in 2018 in Potsdam (UN/OECD Natech-II-Workshop) was subdivided into the following eight sessions, each with its own topics.

Session 1: Natech Risk Management in Industry

Session 2: Natech Risk Analysis

Session 3: Consideration of Climate Change, Consideration of Natech Risk in Adaption to Climate Change

Session 4: Warning systems, Natech Emergency Planning, Preparedness and Response

Session 5: Follow-Up of Events, Event Analysis, Recovery, Rehabilitation, and Reconstruction

Session 6: Transboundary and International Cooperation

Session 7: Natech Risks: Communication and Education

Session 8: Natech Risk Management in the Public Sector: Natech Risk Governance, Enforcement, and Reduction

According to these sessions, the state of the art and research will be presented on the basis of the presentations that were held at the workshop.

## 6.1 Session 1: Natech Risk Management in Industry

Natech Risk Management covers prevention of, preparedness for, and response to chemical accidents. From the view of an operator, one part of prevention is a Natech risk analysis. As a second step, prevention includes the dimensioning of technical and the planning of organizational safety measures. Response to chemical accidents means: Measures to mitigate the consequences of fires, explosions and chemical releases in case of an accident.

In the first OECD-Natech-workshop 2012 it was pointed out that Natech risks can be more important than other industrial risks (caused e.g. by technical failure) and should be part of the operator's risk analysis. Natech risk analysis should be performed before siting a new facility and reviewed for existing plants under the aspect of natural hazards and climate change aspects. It was also elaborated that operators are responsible for managing the risks related to their facilities including Natech risks. They should not only rely on protection measures against natural hazards provided by governments and their authorities. Furthermore, (Natech) risk analysis methods or tools for industrial facilities should be developed and implemented.

In the frame of the UN/OECD Natech–II-project it has to be checked, whether these recommendations are implemented in practice. The task for operators to establish an effective Natech Risk Management is difficult and requires knowledge, which they usually do not have. This is particularly true for Natech risk analysis. Therefore, it seems to be useful to give the operators guidance to help them to fulfil their duties to safeguard their plant against natural hazards. Hence, guidelines or detailed methodological approaches are of great importance for an effective Natech Risk Management in the private sector.

In this context, Cozzani pointed out in his presentation for the UN/OECD Natech-II-Workshop 2018 that the failure of utilities or safety barriers caused by natural hazards had triggered chemical accidents in many cases. Hence, the roles of utilities and safety barriers should be recognized as key points in the assessment of Natech scenarios. Therefore, a specific assessment of safety barrier performance in Natech conditions is needed for an appropriate management of Natech risk. Besides the critical equipment, more attention should be devoted to the design and protection of critical utilities in Natech conditions.

A specific problem of Natech Risk Management is the exposal of pipelines to geological hazards. Earthquakes, volcanism, landslides, avalanches of mud or debris, erosion, floods and rain are examples of natural hazards with impacts on the integrity of pipelines. The strength and stiffness of the pipelines allow them to tolerate the effects of natural hazards for some degree or period of time. The degree and amount of time depend on the strength and deformability, the stress state, the age, the conditions of installation and operation of the pipelines and their geometric arrangement with regard to the hazardous processes.

In the programs for pipeline integrity management, the risk is defined as a function that relates the probability of the pipeline rupture and the consequences of the failure. During the UN/OECD Natech-II-Workshop, Amórtegui proposed that the function is separated in the two following principal elements: the probability of occurrence of the threatening process (hazard) and the pipeline's capacity to tolerate it. He proposes a general function, which is the product of the probability of occurrence of the threatening process, the vulnerability of the pipeline (expressed as the fraction of the potential damage the pipe can undergo), and the consequences of the pipeline failure (represented in the sum of the costs of the spilled product, its collection, the pipeline repair and the damages made by the rupture).

Another approach for pipeline risk management was presented by Aristizàbal-Ceballos. He presented a model to assess the loss of containment due to natural hazards under specific condition: vulnerability of the pipeline, geotechnical susceptibility and triggering agents' activity (e.g. rains, earthquakes, human processes). The model allows integrating the actions carried out to know the pipeline integrity condition and its exposure degree to environmental conditions, to processes of instability susceptibility and, in some cases, the geohazards criticality degree in the face of its existence, and the monitoring of agent activity results (e.g. climatic variability phenomena).

Tabatadze presented an example of Natech Risk Management in Georgia of an existing risk assessment, existing safety and security measures in a factory, incident responder teams, technological processes, and inspection procedures of environment supervision department.

## 6.2 Session 2: Natech Risk Analysis

The Natech Risk Analysis in the industry was the subject of session 2. Natural hazard maps provided by national authorities are the basis for assessing the vulnerability of establishments, facilities or installations by their operators. Due to different types of equipment and also different types of natural hazards many approaches for Natech Risk Analysis are developed.

Using the chemical accident of ARKEMA at their site at Crosby, which was triggered by the hurricane Harvey, Kelly addresses the causes that have led to the failure of the cooling systems including those on three trucks loaded with organic peroxides. He pointed out that in this case, flood information including the water level ought to have been incorporated into the emergency management plan. Environmental impact assessment (EIA) should, thus, consider risks by Natech events. For Kelly it is necessary that EIA results need to be updated as part of on-going emergency management planning to verify projections and to ensure updated plans based on changing nature of hazards.

Sari considered domino effects in case of a chemical accident. His approach includes non-process hazards like earthquake or tornado and process hazards like fire, blast, toxic smoke, and loss of containment. First, the risk of each individual hazard is quantified, and subsequently, the risk for domino effects triggered by fire, blast, and earthquake is assessed. For instance, in case of a fire, the domino effect can be estimated by calculation of the time to failure of tanks as a function of thermal radiation for different levels of utilization. Further, in case of an earthquake, Sari uses fragility curves to estimate the damage of tanks. With this information, the presented risk analysis method can estimate the probability of escalation of primary accidents.

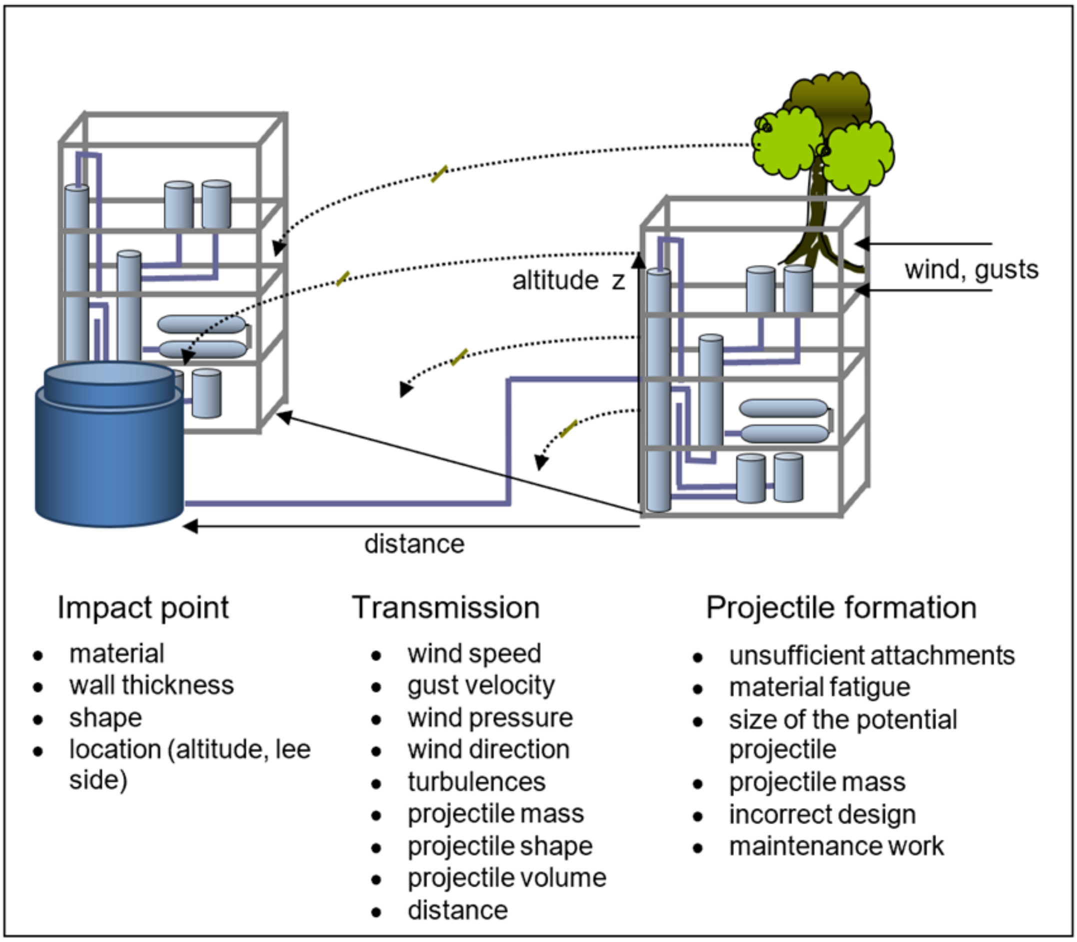
Girgin presented Natech risk analysis and mapping with the RAPID-N system. RAPID-N analyses Natech risks at local (single installations) or regional (multiple installations) level. It covers all functionalities required for Natech risk assessment including natural-hazard assessment, industry damage severity and probability estimation, accident scenario building, and consequence analysis in one tool. The output of the RAPID-N assessment is a risk summary report that features all parameters supplied by the user and utilized by RAPID-N for the analysis and an interactive risk map showing the specific impact areas for all potential Natech scenarios. RAPID-N is currently implemented for earthquake- and flood-triggered accidents in the chemical and process industry, as well as for overland pipelines. It supports land-use and emergency planning and in case of a natural disaster it facilitates decision making based on near real-time damage assessment.

In particular, the intensities of earthquakes are easily measurable. Therein, the peak ground acceleration is of special interest. The damages of equipment are divided into different damage states, assigned to the peak ground acceleration and statistically evaluated. With these parameters the probabilities of the impacts on the environment, like release of chemicals, fire, and explosion, can be estimated.

With the help of such vulnerability curves the degree of loss of integrity including the release of chemicals can be estimated. Even in case of a fire or explosion the thermal radiation can be calculated with the help of Rapid-N. In this way, hazard maps are created that illustrate the critical radius of thermal radiation (mapping by RAPID-N presented by Girgin).

In addition to these approaches, some other risk analysis methods are developed for specific problems. For instance, Köppke considers the hazard of windborne debris triggered by extreme wind. As storms have a huge impact on structures and industrial installations it cannot be excluded that insufficiently attached parts can tear off. If these parts are safety relevant equipment, this may cause the loss of safety-relevant functions. Additionally, the storm may carry these parts away as windborne debris and this may damage safety-relevant equipment, either containing hazardous substances or having other safety-relevant functions.

**Figure 16: Potential Threats Caused by Windborne Debris**



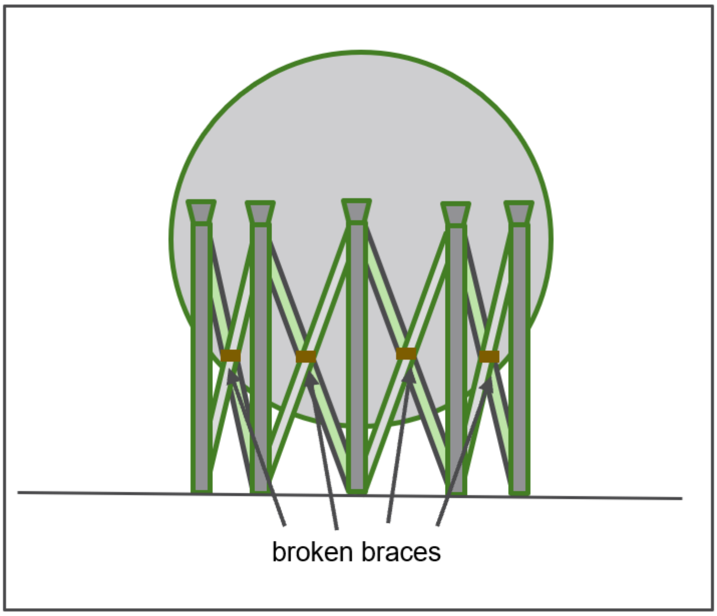

*Source*: Prof. Dr. Köppke & Krätzig & Partner Ingenieursgesellschaft mbH, 2016

The hazard of windborne debris was investigated in the USA due to the high number of tornados and hurricanes in order to develop requirements for the design of community safety rooms. In contrast to tornados, no data and design objects exist for windborne debris generated by other storms and only horizontal air flow. A method was developed in order to generate the necessary data and to estimate the impact of windborne projectiles (pipe) on e.g. tanks. It is an approach to allow a first risk analysis. For this purpose an Excel-based program was developed, which was tested for a refinery close to the coast in the northern part of Germany.

Andres reported about the new Technical Rule on Installation Safety (TRAS 320), which examines the three natural hazard sources wind, snow loads, and ice loads. As a matter of principle, construction works are designed to withstand the wind loads detailed in DIN EN 1991-1-4 (December 2010, previously DIN 1055-4) and the snow loads detailed in DIN EN 1991-1-3 (December 2010) (previously DIN 1055-5 (July 2005), which covered snow loads and ice loads. Safety-relevant technical installations of the kind that are subject to the German Major Accidents Ordinance are not explicitly mentioned in the standards above. Due to their stored or used hazardous substances, these installations have a high risk potential. Hence, particular examination, precautions, and measures to ensure safety are necessary. These installations, including structures and enclosures, therefore need to be designed with particular allowances being made for the static and dynamic loads to which they are exposed.

New research projects resulted from the experience with the tsunami in 2011 in Japan. Ohno deals with countermeasures against large-scale earthquakes at high pressure gas facilities. Significant fire and explosion accident on spherical tanks for Liquefied Petroleum Gas (LPG) storage was induced by the strong ground motion of the 2011 Great East Japan Earthquake. Steel pipe braces were broken due to the strong seismic inertia force, and then the spherical tank lost the horizontal stiffness, and buckling of support legs occurred.

**Figure 17: Broken Braces That Supported the Legs Holding the LPG Tank**




Source: Cosmo Energy Holdings © Karl-Erich Köppke

In this research, seismic capacity of the spherical tank has been evaluated and improved. Furthermore, evaluation methods and seismic reinforcement methods were proposed.

Seismic design standards of high pressure gas equipment in Japan have been revised each time that damage due to earthquakes actually occurred. However, the importance of preparatory measures to prevent unexpected damage was recognized in the aftermath of the damage caused by the Great East Japan Great Earthquake. Therefore, it was examined whether equipment designed on the current seismic design standards could withstand huge earthquakes that are expected in the near future.

Further damage was caused by the earthquake with the following tsunami wave. The results were major floods in the coastal areas. Tsunamis inundation can damage cylindrical storage tanks in such areas. Since those storage tanks have a large amount of oil or gas, the damage can cause an extensive fire. In Japan, a tsunami, which is as large as 2011 Earthquake Tsunami, is predicted to strike again in the near future. Therefore, tsunami wave load acting on storage tanks has to be investigated. The results of this research project were presented by Araki.

Nishino submitted an abstract with an attempt to assess the hazard of tsunami-induced oil spill fires in the vicinity of petroleum industries at Osaka Bay, Japan. The huge tsunami caused large-scale oil spill fires. In particular, some tsunami vertical evacuation buildings were damaged by the fires; consequently, people who had escaped from the tsunami to the buildings were exposed to the fires. Such huge tsunamis are also expected to affect Japan in the near future due to megathrust earthquakes. Therefore, there is a concern about the damage by tsunami-induced oil spill fires in the vicinity of petroleum industries. In order to numerically analyse the thermal impact of tsunami-induced oil spill fires on the surrounding environment, a numerical simulation model has been developed predicting the behaviour of tsunami-induced oil spill fires that is a coupled simulation of tsunami propagation and inundation, oil spill and fire spread, and heat transfer by radiation and convection. It has been confirmed that the model is able to reproduce the dynamic states of the tsunami-induced oil spill fires at Kesennuma Bay in 2011 through numerical simulation.

Since Nishino was caught in Japan by Typhoon JEBI, he was not able to attend the UN/OECD Natech-II-Workshop and hold his presentation. In his stead, Aoki reported of storm surges and their causes in Osaka Bay, Japan i.e. sea level rise caused by low atmospheric pressure and strong wind due to e.g. Typhoons. Typhoon JEBI recorded a sea level rise of about 270 cm above the normal tide level. In his presentation, Aoki stressed that cooperative action for risk reduction by local governments, companies and residents is the most important first step to protect both civil society and industry from Natechs.

Raap reported on measures due to flood hazards at Seveso-sites in the Netherlands with a primary focus on the analysis of effects for floods at chemical industry plants. The presented analysis focused on questions about the extent of the flood risks for Seveso-sites, how the industry can be informed about the risks, what the effects for industry are, and what kind of measures are taken. Also, guidance on how to analyse the flood risk is available, where the basis for a flood scenario is an event which occurs once in 1,000 or 10,000 years.

## 6.3 Session 3: Consideration of Climate Change in Natech Risk Management, Consideration of Natech Risk Adaption to Climate Change

As stated during the Natech-I-Workshop 2012, climate change is likely to affect the intensity, frequency, and geographical occurrence of a range of natural hazards. Facilities are often subject to extreme meteo- and hydrological events and can trigger a second disaster by release of chemicals, fire, and explosion. The following two recommendations are of great importance:

1. New national regulation considering Natechs should take climate change aspects into account.
2. The consideration of climate change in Natech Risk Management should be part of a climate change adaptation process of an enterprise.

The beginning of session 3 focused on the question, whether robust trends of climate change can be deduced from the numerous studies, which all have greater or lesser uncertainties. Hattermann reported about a study, where the different climate-related sources of uncertainty are quantified and discussed when projecting flood hazard and risk. It is shown that robust trends and projections can be found. He demonstrated how these results can be applied in adaptation strategies in the public and private sectors, for example when looking at critical infrastructure.

The integration of climate change into regulatory practice (ICCARP) project was presented by Thomson. This project considers the extent to which adapting to climate change is integrated into environmental permitting practice across Europe. The project focuses on the Industrial Emissions Directive (2010/75/EU) legislation, Integrated Pollution and Prevention Control guidance and analogues.

Bejenaru submitted an abstract about the simulation of river floods in Moldova under the aspect of climate change. The results of investigations in the compilation of hazard and flood risk maps are presented for different probabilities. The hydrological specificity of the Republic of Moldova denotes that the floods caused by the overflowing of the rivers produce less damage and are better managed than the flash floods.

## 6.4 Session 4: Warning Systems, Natech Emergency Planning, Preparedness, and Response

Natech emergency planning is a difficult task, because the specific characteristics of Natech accidents differ significantly from “conventional” technological accidents. Often, several facilities are affected by one natural hazard event at the same time. This can lead to multiple and simultaneous loss-of-containment events in different locations, creating difficulties for response. In addition there can be cascading events, one natural hazard can trigger another one and one Natech may trigger other ones. Finally, in case of a natural disaster, the response to a Natech will be one part of the response to the disaster, i.e. the response to the Natech has to be made under the conditions after a natural disaster.

Necci gave an overview of some Natech events in the past including the main lessons learned for each event. Besides the necessity of on-site emergency plans, their periodic revisions, the health risks for the population and responders caused by chemical release must be considered. Hence, medical services should be involved in the preparation of disaster management and external emergency planning.

Sabanashvili gave a brief overview of the Georgian law on Civil Safety and its relevance for Natech incidents, including the specifics of emergency plans, working specifics and also work concerning Natech risk reduction. Special focus was on discussing population vulnerability and risks of technical accidents during natural emergencies. The presentation also covered early warning systems in Georgia for flood, erosion, landslide and mudflow. A Geo-informational portal has been established and updated with various geographical data, hazard maps, critical infrastructure, dangerous facilities and objects. Also a new communication system has been installed for dissemination of warnings.

In a heavy industrial and populated area of Indonesia, Natech disasters are simulated by ARDEX (ASEAN Regional Disaster Emergency Response Simulation Exercise). Lestari reported about the scenario development and the resulting Natech disaster risk management. The simulations have been executed in the Cilegon area, a region with many facilities and a high risk of earthquakes and tsunamis. One basis for the different simulations are maps with information about the chemical disaster prone areas.

Torres presented an international platform on earthquake early warning systems, which is launched by UNESCO. The main objective of the platform is to assess the current state of the art in the development and operationalisation of earthquake early warning systems (EEWS) globally, to foster dialogue and international cooperation for capacity building around these systems, and therefore to promote and strengthen EEWS in earthquake-prone countries worldwide.

Early warning systems are successfully in operation all over the world. Girgin noted that none of them considers the consequences of Natech disasters triggered by natural hazards. He reports about investigations of the EC Joint Research Center to combine early warning systems for e.g. flood with the Rapid Natech Risk Assessment and Mapping System (RAPID-N), which is an operational system for rapid local and regional Natech risk analysis. In two studies, the interoperability of RAPID-N was assessed. The studies show that Natech-related damage and consequences can be successfully assessed by RAPID-N by using the natural hazard data provided by other systems like the European Flood Awareness System (EFAS) and the Global Disaster Alert Coordination System (GDACS).

Deelstra described the attempt to estimate the facility downtime after Natech accidents. The starting point is the assumption that normally, the individual parts of a plant have a defined repair time. Also, certain resources are needed to repair the individual parts. Furthermore, the damage to the individual parts often depends on other damaged parts. For example, a leaking fuel tank cannot supply a generator. The core elements of the model are fragility curves for tanks in case of an earthquake and restoration curves for tank farms. However, the considerations presented are only a first step in the estimation of facility downtimes, because more information (material properties, internal constraints, external resource requirements etc.) is required to estimate realistic downtimes after Natech accidents.

An unconventional proposal for response was given by Vatenmacher. He determines that during the first hours after an earthquake, there are minimal numbers of specialists and means but many life-saving missions and after 48 - 72 hours, there are a lot of specialists and means, but very low chances to save life after an earthquake event. The first hours after an earthquake are most important, but there are a limited number of professionals (civil engineers), who can evaluate the situation. The solution for this paradox problem is to establish a cascade process of evaluation, using non-professional staff (not civil engineers) during the first critical hours and using the professionals only for special plants or special situations. Therefore, the authorities in Israel have prepared a course of Hazardous Material (HazMat) plants post-earthquake evaluation for non-engineers. The engineers' issues were determined in the simplest way in order to explain the basic principles and to determine/set the go/no go instructions. The additional mean/tool that is required in order to complete this mission is a pocket handbook. The handbook was prepared especially for non-engineers and it was presented in this session.

## 6.5 Session 5: Follow-Up of Events, Event Analysis, Recovery, Rehabilitation, and Reconstruction

Kulinowski reported about some famous natural events and Natechs in order to derive important conclusions for future flood events. Her presentation gave details on the investigation undertaken by the US Chemical Safety Board (CSB) at the Crosby site of the ARKEMA company due to a Natech caused by flooding of the site. One of the main failures was the unexpected water level after the hurricane Harvey. Kulinowski shows, however, that the large number of extreme flood events in Houston in recent years would have allowed conclusions to expect high water levels. Although information about flood hazards is available, this information is not required to be used in process hazard analyses. She pointed out that guidance to industry is necessary.

From the perspective of insurance companies, Schmid pointed out that all over the world, large amounts of money must be spent every year to industry-clients to compensate losses caused by natural catastrophes. Many of these events are predictable. Consistently, he asks why is it necessary to suffer losses from events when loss prevention is possible? Losses are analysed to indicate what hazards effectively impact chemical and petrochemical industries and what loss prevention technics are developed. Positive and negative examples indicate the value of the loss prevention measures for different hazards and conditions.

A specific event analysis was carried out for the Cosmo Oil Refinery in Chiba prefecture affected by the earthquake on 11th March, 2011. In the accident, an initial earthquake induced fire, which induced the burnout of all of 17 LPG tanks because of the escalating fires and explosion or so called domino effects.

**Figure 18: Fire in the LPG Tank Farm of Cosmo Oil Refinery in 2011**

Source: Wikimedia Commons

Maekawa presented the activities in Japan to understand the propagation of dynamics of the accident in order to develop effective countermeasures to prevent such Natech accidents in the future. A research project is started to analyse the dynamics of this accident including the consequences analysis using Bayesian Network.

## 6.6 Session 6: Transboundary and International Cooperation

Wardle explained the UNECE Convention on the Transboundary Effects of Industrial Accidents to support prevention, preparedness and response to Natech events, and to promote cooperation between countries in this regard. The convention supports countries in the identification and assessment of Natech hazards and in taking preventive measures to adjust preparedness and response actions. Seminars on land-use planning and industrial safety as well as guidance development (the safety guidance and good practices on specific industry sectors are examples for the activities of UNECE).

Mara reported about the project 'Hazard Map' which was jointly prepared by the Republic of Moldova, Romania and Ukraine under the UNECE Project on Hazard and Crisis Management in the Danube Delta (2010–2015), in the framework of the UNECE Industrial Accidents Convention's Assistance Programme. The key objective of the project was to protect the Danube Delta (Europe's largest remaining natural wetland) from industrial accidents and to improve cooperation on industrial accidents between the three countries. A major outcome of the UNECE project is the hazard map which visually represents the hazardous industrial activities in the three project countries identified in a harmonized way.

Fanchiotti gave an overview about the activities of the UN Environment/ OCHA Joint Unit (JEU). The JEU supports Member States in responding to environmental emergencies whenever international assistance is requested. This includes readiness for response through specialised training, complex simulation exercises, policy guidelines, and contingency planning. Notably, the JEU has co-led the development of the UNISDR Words into Action Guide on Man-made and Technological Hazards, which also addresses Natechs; developed tools for rapid environmental assessment, such as the Flash Environmental Assessment Tool (FEAT); and provides online e-learning modules via its online Environmental Emergencies Centre. The JEU further engages with UN Environment on the Awareness and Preparedness for Emergencies at Local Level (APELL) programme, as well as with the OECD through the Working Group on Chemical Accidents and on the UN/OECD Natech-II-project.

Zhanguzhinov submitted an abstract that reports about an agreement between the Republic of Kazakhstan and the Kyrgyz Republic on the establishment of a centre for emergency situations and disaster risk reduction. Harmonization of legislation, strengthening local and national capacities for emergency management, and coordination of an effective response to emergencies are tasks of the centre.

## 6.7 Session 7: Natech Risks: Communication and Education

Due to the complexity of Natech science, Danihelka proposed to establish Natech-specific education and capacity building. This includes the communication between all involved disciplines like technology, geology, hydrometeorology, and management. Risk management needs generalists, which leads Danihelka to propose establishing a new discipline for risk management and to develop relevant and high-qualified competences for risk management.

Ydirín Alonso presented the National Risk Atlas in Mexico, a tool for the identification of risks and the preparation of decisions. The atlas consists of databases, geographic information systems, and tools for the analysis and simulation of scenarios, as well as the estimation of losses due to disasters. For example, the user can obtain information about the location of companies that use highly hazardous substances (flammable or toxic) and the danger they pose to the population and natural systems. Another example is the identification of the vulnerability of the population and systems to rain and tropical cyclones according to their exposure, as well as their social- and geographical conditions. For the dynamic nature of the risk, it must be maintained as a permanent updating instrument. It also includes tools, e.g. the National Alert System for cold fronts, slope slides, rain and tropical cyclones, to improve the safety of the population in case of imminent risk for local authorities and the population.

Jibiki investigated the relationship between the industry and the local community for building a Natech early warning system. One of the main problems of early warning systems is the dissemination of warnings. He presents the results of a survey in Cilegon City located in Banten Province which is known as one of the most famous petrochemical industrial areas in Indonesia. This area is susceptible to earthquakes und tsunamis. These major hazards may increase risks in communities surrounding industrial areas. The aim of the survey was to empirically clarify the relationship between the industry and the local community and to obtain implications for developing a Natech early warning system. Cilegon is potentially exposed to natural and industrial hazards and considered as an adequate place for studying Natechs. Jibiki concluded that the implementation of simulation and trainings at the community level is useful to raise awareness of the Natechs and for identifying practical actions.

Cruz complained that, despite of huge efforts on disaster education and preparedness for natural hazards in Japan, there are still huge gaps of information for industrial and other man-made hazards. Unfortunately, despite of the experience with the Cosmo Oil disaster and the nuclear accident at the Fukushima Dai-ichi power plant in 2011 in Japan, there is currently little to no hazard or risk information concerning the risk posed to residents from chemical and Natech accidents, nor on what residents can or should do to reduce their potential impacts. Other Asian countries face similar problems. Cruz discussed barriers and challenges to risk information, disclosure and communication concerning Natechs.

## 6.8 Session 8: Natech Risk Management in the Public Sector: Natech Risk Governance, Regulation, Enforcement, and Reduction

Gagnaire gave an introduction to the French regulation for earthquakes in industrial establishments (including Seveso establishments), while the concrete prevention of Natech Risks due to earthquakes at Seveso establishments was explained by Candé. In France, seismic legislation commands that “special risk” equipment in specific hazardous areas must be analysed. The objective of these analyses is to prove the non-vulnerability of special risk equipment to seismic hazards or, if necessary, to define a certain number of reinforcement measures. In order to help stakeholders in these studies, a consortium gathering industry and trade associations, with the participation of INERIS, has developed methodological and technical guides to help industrials in these studies.

In addition to these French activities, Astorri presented the Natech Risk Management in Italy. With the implementation of the Seveso III Directive (2012/18/EU) in 2015, and with the experience of some heavy earthquakes in Italy during the last 10 years, the responsible authorities started activities to reduce the potential risk of Natech accidents. Rules, guidelines, and technical standards should enable operators to apply uniform mitigation prevention strategies and response to accident hazards induced by a natural event. Astorri’s presentation regarded the technical-scientific activities carried out by ISPRA- the technical body of the Ministry of Environment of Italy, to support operators and authorities on setting up the prevention and mitigation action of Natech events.

Suarez-Paba presented the current Natech Risk Management status in Colombia. She reported that the Colombian government has made efforts to create a national disaster risk management system by passing the Law 1523 in 2012. This law expressly establishes the obligation for all public and private installations involved in industrial activities, to carry out risk analysis. This analysis must consider the possible effects of natural hazard events on the exposed infrastructure and the potential external consequences on the surrounding areas. Due to the fact that this law is relatively new, many deficits can still be identified in practice. All in all, a lack of knowledge on the specificities of Natech scenarios has shown the need to strengthen this issue in order to improve preventive mechanisms and response capacities in the Colombian context. In conclusion, even though there is increased awareness among governmental organizations on the importance of assessing and managing Natech risks, efforts still need to be directed towards consolidating Colombia’s Natech Risk Management system.

# 7 Record of Examples of Good Practice in Natech Risk Management

The Natech Addendum (OECD 2015) to the OECD Guiding Principles on Chemical Accident Prevention, Preparedness and Response (OECD 2003) states in chapter 18.g.2

*"Countries should exchange experience concerning good practices for Natech prevention, preparedness and response including natural hazard identification, hazard mapping and natural disaster management".*

Following up upon this recommendation, the UN/OECD Natech-II-project set out to develop a record with examples of good practice in Natech risk management. The aim was to raise awareness on the issue of Natechs and to distribute knowledge of cases where aspects of Natech risk management have been successfully implemented by various stakeholders. The record is to be published online in the form of a directory of several individual fact sheets. Several sources of information were used for researching the cases.

The 2017 survey asked for 16 possible areas in which examples of good practice in Natech Risk Management might be found. There was wide variation in the replies, revealing that in some areas many responding countries have taken significant steps, while in others considerable work remains to be done. In addition to the responses to the survey, numerous examples of good practice were researched and evaluated, to be brought in the form of short profiles. Other sources of information were the abstracts that were handed in by speakers, online research, as well as contacts made at the UN/OECD Natech-II-Workshop and at the sessions of the WGCA. The final record of good practice examples will be published separately to this report, due to its large filesize.

## 7.1 Structure of the Record

All example-sheets were collected in one record of good practice examples. The record is structured along the lines of the structure of the OECD Guiding Principles in Chemical Accident Prevention, Preparedness and Response, as well as the structures of the Natech-I-(2012) and UN/OECD Natech-II-(2018) Workshops. More precisely, the 12 chapters in which the examples are classified are:

1. Natural Hazards Identification and Communication, Natural Hazards (Early) Warning Systems
2. Consideration of Natural Hazards in Siting / Land Use Planning;
3. Natural Hazard Analysis and Natech Risk Analysis;
4. Natech Prevention: Consideration of Natural Hazards in Design and Layout;
5. Natech Risk Prevention: Consideration of Natural Hazards in Operation and Procedures;
6. Natech Risks in Emergency Planning, Preparedness, and Response;
7. Consideration of Natech Risks in Risk Communication and Natech Warning Systems;
8. Natech Risks in Regulations, Standards, Codes, and Guidance;
9. Natech Risks in Enforcement and in Follow up to Natechs;
10. Natech Risks in Education and Training;
11. Natech Risks in Transfer of Technology;
12. Natech Risks in Transfrontier or International Cooperation.

## 7.2 Structure of the Fact Sheets

Each example is designed as a fact sheet of no more than two pages (see example below). In order to put the examples in perspective concerning the three international frameworks most important for Natech Risk Management, three drop-down menus were established for each example, from which to choose which part of

a) the OECD Guiding Principles on Chemical Accident Prevention, Preparedness and Response (OECD 2003),

b) the Sendai Framework on Disaster Risk Reduction, and

c) the Sustainable Development Goals (SGDs)

are most applicable to each example in question. Furthermore, each fact sheet consists of several info-boxes as well as a graphic (where applicable) to serve greater accessibility of and comparability among the examples.

Firstly, for a quick and easy access, key figures and information are given in a text box about "short facts". This includes information about the kind of approach (e.g. plan / regulation / program), about the issuing institution (e.g. government / ministry / company / international organization), the year of publication or entry into force, the targeted actor (e.g. operators / public authorities), and the area of applicability (e.g. national + country / county + regions / international / installation + company).

In a second info box, it is clarified which natural hazards are considered in the example, due to the fact that different natural hazards may require different planning or response mechanisms. A flood, for instance ought to be treated differently than extreme heat or drought, while an earthquake may again require different protection measures. Furthermore, depending on the readership of the record, only some natural hazards may be interesting or relevant for the reader.

A third text box indicates whether the cross-cutting issue of climate change is tackled or considered in the example at hand. Are, for instance, predictions of the expected adverse effects of climate change taken into account in the planning?

Fourthly, a text box including (if applicable) a web link to further information on the example as well as a contact person, is included in the fact sheet.

A larger fifth box on page two contains a concise description of the example in text form. It was tried to keep the language accessible also for readers who are none-too familiar with the issue of Natechs. This should also make the translation of the examples by the OECD less difficult and make it easier to read for addressees whose native language is not English. Lastly, a text box was inserted for comments by the Steering Group.

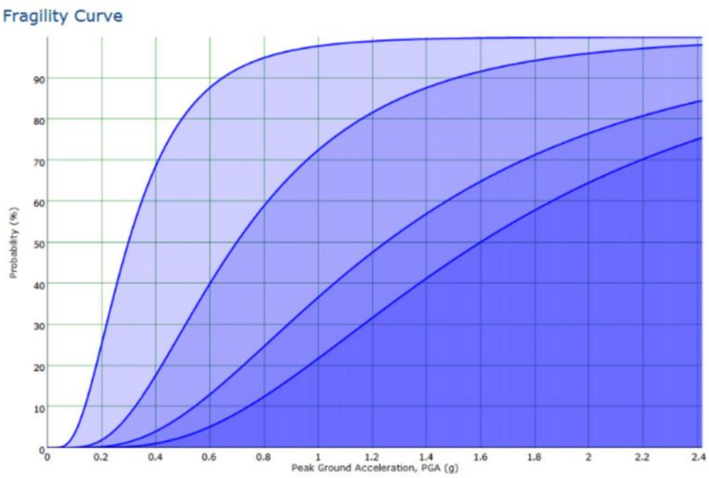
## 7.3 Example of a Factsheet

### (RAPID-N) Methods for Natech Risk Assessment – RAPID-N (European Union)

Table 2: Classification of Rapid-N

| OECD GP Activity | UN SF Activity | UN SD Goals / Targets |
|---|---|---|
| 3. Natural hazard analysis, Natech Risk Analysis | 1. Understanding disaster risk | 17.6 Enhance ... regional and international co-operation on and access to science, technology and innovation and enhance knowledge sharing ... |

Figure 19: Fragility curve of an anchored on-ground steel tank




*Source:* © European Union, 1995-2019

Table 3: Fragility data of an anchored on-ground steel tank

| No. | Damage State | Median | Standard Deviation |
|---|---|---|---|
| 1. | ≥ DS2 | 0.3 | 0.6 |
| 2. | ≥ DS 3 | 0.7 | 0.6 |
| 3. | ≥ DS4 | 1.25 | 0.65 |
| 4. | = DS5 | 1.6 | 0.6 |

Table 4: Short facts on Rapid-N

| Short Facts | Natural hazard(s) considered: | Climate Change |
|---|---|---|
| **Governance approach:** Risk Assessment<br>**Source:** Joint Research Centre, European Commission<br>**Entry into Force:** 2014<br>**Targeted Actor:** Authorities, Operators<br>**Geographical applicability:** world wide | • Earthquake<br>• Flood (prototype) | So far not considered |

**Link/Contact:**

http://rapidn.jrc.ec.europa.eu/
S. Girgin European Commission Joint Research Center, Ispra
Provided by Elisabeth Krausmann: elisabeth.krausmann(at)ec.europa.eu

**Description:**

For the mitigation of Natech risk, authorities need to identify Natech-prone areas in a systematic manner. In order to facilitate Natech risk analysis and mapping, a unified methodology was developed that is based on the estimation of on-site natural hazard parameters, determination of damage probabilities of plant units, and assessment of probability and severity of possible triggered Natech events. The methodology was implemented as an on-line, extensible risk assessment and mapping software framework called RAPID-N, which allows rapid local and regional Natech risk assessment and mapping with minimal data input. RAPID-N features an innovative data estimation framework to complete missing input data, such as on-site natural hazard parameters and plant unit characteristics. The framework is also used for damage assessment and Natech consequence analysis, and allows easy modification of input parameters, dynamic generation of consequence models according to data availability, and extension of models by adding new equations or substituting existing ones with alternatives. Results are presented as summary reports and interactive risk maps, which can be used for land-use and emergency planning purposes by using scenario hazards, or for rapid Natech consequence assessment following actual disasters. As proof of concept, the framework provides a custom implementation of the U.S. EPA's RMP Guidance for Offsite Consequence Analysis methodology to perform Natech consequence analysis and includes comprehensive data for earthquakes.

RAPID-N was designed for estimating Natech risks. The risk areas are illustrated in environment maps and can support land-use planning and emergency planning. The probabilities of plant unit damage is estimated as well as the consequences of a natural event. In a first step the tool was developed for earthquake risks. A prototype for flood Natech risks is available.

RAPID-N consists of the following 4 modules:

Scientific Module: This module supports scientific tasks and calculations but it also provides the property estimation framework upon which the RAPID-N risk assessment functionality is built. This framework reduces the amount of data to be entered by the users.

Industrial Plants and Unit Module: For estimation of the probability of the damage severity the tool needs information about the type of equipment, dimensions, structural properties, operating and storage conditions, and hazardous substances contained in the unit.

Natural Hazard Module: Using the source characteristics of a natural hazard (e.g. for earthquake: epicenter, magnitude, severity, local depth) RAPID-N can calculate the natural-hazard characteristics (e.g. peak ground acceleration [PGA] and velocity) at the location of the hazardous installation which is needed for the damage and risk assessment.

Natech Risk-Analysis Module: This module calculates the natural-hazard damage to industrial units, performs the consequence analysis, and maps the results in a GIS environment. Based on the natural-hazard intensity and the plant location, the probabilities of damage can be estimated with the help of equipment fragility curves. Equipment damage is divided into different damage states, with different probabilities for each as a function of natural-hazard intensity (e.g. PGA) and statistically evaluated. The severity and probabilities of the Natech scenarios triggered by the damage states, like release of chemicals, fire, and explosion, can be estimated.

**Comments by the UN/OECD Natech-Steering Group:**

# 8 Recommendations of the Survey, the UN/OECD Natech-II-Workshop Sessions, and Further Discussions

Prior to the workshop on Natech Risk Management in 2018 in Potsdam (UN/OECD Natech-II-Workshop), the critical examination of the survey in 2017 as well as of the abstracts for the Workshop had suggested deficits in Natech Risk Management. Chapter four of the discussion document had suggested possible recommendations to solve these deficits, while taking reference also to the key-recommendations in chapter 18 of the OECD Guidance on Chemical Accident Prevention, Preparedness and Response (OECD 2003) on Natechs (2nd Addendum on Natechs (OECD 2015). This chapter four was now updated to mirror the presentations and recommendations that were made during the UN/OECD Natech-II-Workshop and the following discussions in the Steering Group.

To avoid duplications in the discussions, the already existing recommendations on Natech Risk Management in chapter 18 of the Guiding Principles (OECD 2015) are given below in *grey italics*.

The recommendations that are based on the results of the survey, the discussion document, the evaluation of the abstracts, the discussions at the UN/OECD Natech-II-Workshop, and the review of the UN/OECD Natech project steering group are given below in *green italics*. These recommendations are a mere draft and will require further discussion in the OECD Working Group on Chemical Accidents before they can be formalised and possibly added to the OECD Guiding Principles.

***a. Hazard Mapping***

*18.a.1 Public authorities should collect data related to natural hazards and natural disasters, and use this to develop natural hazard maps, which are important tools for the dissemination of information on natural hazards.*

*18.a.2 Adequate training should be provided to those responsible for preparing and using natural hazard maps in the context of, for example, siting of hazardous installations, land-use planning, designing and operating hazardous installations, and emergency planning.*

*18.a.3 Further efforts should be undertaken to improve the methodologies and tools for preparing hazard maps and for Natech risk analysis.*

***b. Risk Assessment***

*18.b.1 When undertaking risk assessments related to hazardous installations, management of should take account of Natech risks.*

*18.b.2 Management should use a clear methodology for identification and assessment of Natech risks.*

*18.b.3. Management should be aware, and take account, of the fact that climate change may increase natural hazards. For example, climate change might affect the intensity, frequency and geography of natural hazards. Therefore, management should consider: assessing regional climate change projections; developing an adaptation strategy; implementing enhanced safety measures; and updating assessment and measures as further information becomes available.*

*18.b.4 Management of existing installations should periodically review their risk assessments, and safety management systems, in light of new information and experience related to natural hazards.*

*18.b.5 Management should maintain a dialogue with the public authorities with regard to the status of natural hazard assessments such as seismic zone maps and flood risk maps.*

***c. Risk Management***

***Design and Construction***

*18.c.1 Management should take into account natural hazards in the design and construction of hazardous installations.*

***Operation***

*18.c.2 Management should develop appropriate measures to address natural hazards. For example, special procedures may be needed for extreme meteorological conditions such as heavy precipitation, high winds, and low or high temperatures.*

***d. Siting and Land-Use Planning***

*18.d.1 Management should perform a Natech risk analysis before siting a new installation, to identify what location would be the most effective and least expensive approach to Natech risk reduction.*

*18.d.2 When establishing land-use planning arrangements and policies related to hazardous installations, public authorities should take into account natural hazards such as floods, extreme temperatures, high winds, earthquakes, and wildfires as well as the possible impacts of climate change.*

*18.d.3 Adequate training in Natech Risk Management should be provided to those responsible for the siting of installations and land-use planning.*

***e. Regulations***

*18.e.1 In developing and reviewing regulations and guidance concerning chemical accident prevention, preparedness and response, public authorities should take into account risks associated with Natechs.*

***f. Preparedness and Response***

***Preparedness Planning***

*18.f.1 Existing emergency plans should be reviewed to be sure they address the possible consequences of earthquakes, floods, extreme temperatures and other natural hazards that might trigger Natechs.*

***Warning Systems***

*18.f.2 Natural hazard warning systems should be regularly tested, maintained, and updated to inform companies and communities of impending natural hazards or disasters, to the extent practicable.*

***Response***

*18.f.3 Response personnel should be provided with available information to be most effective in addressing Natechs.*

***G. Transboundary Co-Operation***

*18.g.1 Neighbouring countries should cooperate in Natech prevention, preparedness and response.*

*18.g.2 Countries should exchange experience concerning good practices for Natech prevention, preparedness and response including natural hazard identification, hazard mapping and natural disaster management.*

***H. Polluter Pays Principle***

*18.h.1 Countries should consider how to apply the Polluter Pays Principle in the context of chemical accidents triggered, or made worse, by natural hazards.*

As a general note, it surfaced during the UN/OECD Natech-II-Workshop that many participants felt the need to express what distinguishes Natechs from other chemical accidents. Natech Risk Management may require measures usually not covered by chemical accident management. Natech risks have certain properties that set them apart from other chemical accidents.

Some of them may be:

1. The triggering, propagation and consequences of Natechs may not be covered by "conventional" chemical accident scenarios, used for design and layout of facilities.
2. Natech risk management requires the involvement of experts for natural hazards, in many cases of civil or hydraulic engineers; the knowledge of these experts must be integrated in risk studies for "chemical" installations.
3. Natural hazards that are not extreme also have the potential to cause Natechs.
4. Natural hazards can affect several installations at the same time; they can cause a series of Natechs.
5. Natural Hazards can cause cascading events e.g. one natural hazard may trigger another one.
6. Climate change can cause some natural hazards to occur at locations where they have never been observed previously or cause them to occur more severely or more frequently.
7. In case of natural disasters, the vulnerability of the population will be increased; a Natech in these situations will have more severe consequences then an equivalent chemical accident at other times.
8. During natural hazards/natural disasters the availability and capability of emergency responders can be limited.

Hence, the first recommendation that was made during the UN/OECD Naetch-II-Workshop is:

*1. Awareness needs to be raised of the specific characteristics of Natech risks compared to other chemical accident risks, such as different causes, scenarios, and consequences.*

From taking into account the result of the survey on Natech Risk Management in 2017 that less attention is paid to the abovementioned recommendations than to binding regulations e.g. the requirements of the EU Seveso-Directive (2012/18/EU) (question 2), it was recommended that

2. *Governments, authorities, and industry [management] should develop methods and instruments to support the implementation of the already existing recommendations on Natech Risk Management in the OECD Guiding Principles on Chemical Accident Prevention, Preparedness and Response (Guiding Principles). This can reach from consideration in legislation, guidance, safety management, siting and land-use planning to education and training of staff, operators, and authorities.*

A result from question 1, 2, and 4 of the 2017 survey, as well as from a comparison with the answers from the survey in 2009, is that the respondents take less account of the preparedness for Natech Risks in effectiveness of regulations, awareness, training of staff, practices for chemical accident prevention, industry's methods for risk assessment, and civil engineering of installations in 2017, than they did in 2009. The respondents seem to regard the level of preparedness for Natech Risk more sceptically than in 2009.

One result from part IV of the questionnaire in 2017 is that several countries have measures and instruments considering Natech Risk in place, but only few of them regard examples of them as good practice.

3. *This means there is a need to improve the quality in Natech Risk Management (even where it is in place) by development, identification, communication, dissemination, and implementation of good practice examples. This should include:*
   a) *regulations and guidance,*
   b) *siting of and land use planning for hazardous facilities,*
   c) *safety management at hazardous facilities,*
   d) *consideration of Natech risk in risk analysis for hazardous facilities [including in safety reports/documents, and emergency plans],*
   e) *consideration of climate change in Natech Risk Management,*
   f) *consideration of natural hazards in special operation procedures for hazardous facilities [e.g. extreme weather conditions],*
   g) *design and construction of installations,*
   h) *consideration of Natech risks in inspection systems and inspections,*
   i) *enforcement of Natech Risk Management requirements at existing installations / facilities,*
   j) *cross border and international cooperation in natural hazard mapping and warning systems, and*
   k) *education and training of staff of authorities and of hazardous facilities.*
4. *A database of good practice examples in Natech Risk Management should be elaborated and accessible online.*

## 8.1 Recommendations on Natural Hazard Mapping

One of the most important sources of natural hazards identification and for Natech risk analysis are natural hazard maps (including electronic information systems). Natural hazard maps are necessary for the operators for siting of facilities (e.g. to avoid siting in earthquake or flood hazard prone areas), layout of installations, dimensioning of protection and prevention measures (e.g. dikes in case of flood hazards), and to prepare for response and mitigation activities including emergency planning. However, it is furthermore important, that operators understand the information provided. Depending on the specific location, it should be recommended that natural hazard maps should address all relevant types of hazards that may cause major accidents. Information about multi-hazard risks seems to be necessary.

As the basis of hazard mapping can differ, it was recommended to develop consistent requirements for natural hazard mapping during the UN/OECD Natech-II-Workshop. This can be done e.g. by specifying probabilities. Natural hazards do not stop at national borders. So transboundary and international cooperation is recommended for natural hazard mapping and this requires to have the same basis (compare chapter 8.7). This seems particularly useful for extreme precipitation events, as they occur more and more frequently.

The existing recommendations on Natural Hazard Mapping in chapter 18 of the OECD Guiding Principles are

*18.a.1 Public authorities should collect data related to natural hazards and natural disasters, and use this to develop natural hazard maps, which are important tools for the dissemination of information on natural hazards.*

*18.a.2 Adequate training should be provided to those responsible for preparing and using natural hazard maps in the context of, for example, siting of hazardous installations, land-use planning, designing and operating hazardous installations, and emergency planning.*

*18.a.3 Further efforts should be undertaken to improve the methodologies and tools for preparing hazard maps and for Natech risk analysis.*

The 2017 survey makes aware of existing deficits in implementation of these recommendations:

5. *Thence, there is a need for*
    a) *elaboration and implementation of multi-hazard maps,*
    b) *development of criteria for the elaboration of natural hazard maps to reach standards in natural hazard mapping,*
    c) *improvement in cooperation between neighbouring countries for cross-border natural hazard maps,*
    d) *improvement in the communication of natural hazard maps/information between authorities, experts and operators of industrial facilities in identified risk zones, and*
    e) *improvement in understanding by the operators of the probability and intensity of natural hazards threatening their sites.*

The annexe II includes examples of good practice in natural hazard mapping and communication, e.g. the Hazard Map of the Danube Delta, which was jointly developed by the Republic of Moldova, Romania and Ukraine under the UNECE Project on Hazard and Crisis Management in the Danube Delta.

## 8.2 Recommendations on Natech Risk Management in Industry (Session 1)

As the survey in 2017 has shown, nearly 70% of the responding countries have no guideline specific for Natech Risk Management in their country. On the other hand, 100 % of the answers assert that natural hazards are taken into consideration in risk management at vulnerable installations. It can be assumed that in many cases such considerations are rather intuitive.

In order to ensure certain minimum standards for Natech Risk Management, the development of guidance seems necessary. It is also conceivable that certain methodological approaches or tools should be recommended in technical guidelines. This would also facilitate the inspections by authorities.

As the presentations in session 1 of the UN/OECD Natech-II-Workshop have shown, there are certain areas, e.g. pipelines for which interesting approaches have been developed for Natech Risk Management in industry. However, these usually do not cover all safety-relevant installations and their systems. This concerns, for example, the electrical system, process control technology, cooling systems, etc. Therefore, it seems necessary to develop a general guideline, which is to be applied in principle. The guideline should respond to, for example, the following questions:

- What potential Natech risks exist at the location of safety relevant establishments? How can these be identified, analyzed, reduced, and managed?
- What are the obligations for operators to ensure successful Natech Risk Management?
- What preconditions need to be fulfilled to ensure that operators can meet such obligations?
- What technical and operational measures can be applied to reduce Natech risks?
- Which possibilities exist to mitigate release of chemicals or the consequences of fire and explosion?

Considering Natech Risk Management in industry, the following recommendations are listed in chapter 18 of the OECD Guiding Principles**:**

*18.a.2 Adequate training should be provided to those responsible for … siting of hazardous installations, … designing and operating hazardous installations ...*

*18.b.1 When undertaking risk assessments related to hazardous installations, management of should take account of Natech risks.*

*18.b.2 Management should use a clear methodology for identification and assessment of Natech risks.*

*18.b.3. Management should be aware, and take account, of the fact that climate change may increase natural hazards. For example, climate change might affect the intensity, frequency and geography of natural hazards. Therefore, management should consider: assessing regional climate change projections; developing an adaptation strategy; implementing enhanced safety measures; and updating assessment and measures as further information becomes available.*

*18.b.4 Management of existing installations should periodically review their risk assessments, and safety management systems, in light of new information and experience related to natural hazards.*

*18.c.1 Management should take into account natural hazards in the design and construction of hazardous installations.*

*18.c.2 Management should develop appropriate measures to address natural hazards. For example, special procedures may be needed for extreme meteorological conditions such as heavy precipitation, high winds, and low or high temperatures.*

*18.d.1 Management should perform a Natech risk analysis before siting a new installation, to identify what location would be the most effective and least expensive approach to Natech risk reduction.*

*18.d.3 Adequate training in Natech Risk Management should be provided to those responsible for the siting of installations and land-use planning.*

Point 18.b.2 requires the use of a clear methodology for identification and assessment of Natech risks. Furthermore, the management should observe climate change, which might affect the intensity, frequency and geography of natural hazards (18.b.3). This includes the design and construction of hazardous installations (18.c.1).

However, after a critical evaluation of these recommendations, it is important to note that enterprises often do not know how to implement these recommendations. Therefore, guidelines for Natech Risk Management are required.

These guidelines may especially give advice for the consideration of Natech Risk Management

1. in elaboration and up-dating of safety documents (EU Seveso-Directive: safety reports) including Natech risk analysis and assessment and
2. in emergency plans of operators of hazardous facilities.

The guidelines can be supplemented by individual good practice examples.

The recommendation related to Natech Risk Management in industry is:

6. *On the basis of identified good practice examples in Natech risk management international or national guidance for Natech Risk Management in industry should be elaborated.*

This may include different guidance for different levels of management, e.g. there may be guidance on Natech Risk Management for the level of corporate governance as well as for the technical management.

## 8.3 Recommendations on Natech Risk Analysis (Session 2)

Session 2 of the UN/OECD Natech-II-Workshop introduced new application examples for Natech risk analysis. These include, for example, the methods according to Rapid-N for tanks in case of an earthquake, risk analysis for pipelines, risk analysis for windborne debris, the design for LPG-tanks, and evacuation shelters. However, it must be taken into account that there are also other safety relevant parts of hazardous facilities that are not included in the presented risk analyses.

Considering Natech Risk Analysis, the following recommendations are listed in chapter 18 of the OECD Guiding Principles**:**

*18.b.2 Management should use a clear methodology for identification and assessment of Natech risks.*

*18.a.3 Further efforts should be undertaken to improve the methodologies and tools for … Natech risk analysis.*

As the abstracts and presentations of session 2 show, Natech risk analysis is often focussed on particular natural hazards such as earthquakes, and special parts of a facility such as tanks or pipelines. But Natech risk analysis needs to consider all natural hazards relevant at a site and all endangered and risk contribution parts of installations or facilities.

7. *Therefore, Natech risk assessment, including risk analysis, will require further development e.g. for*

a) *scenarios unique for natural hazards [e.g. multi-hazard scenarios],*

b) *Natech scenarios for complex installations or*

c) *Natech scenarios that can be more complex than other accident scenarios.*

Hence, it is recommended to

8. *collect and evaluate examples of Natech risk analysis approaches to identify good practice methods that should be addressed in the guidance for Natech Risk Management in industry (see above),*
9. *industry to update their safety management to consider changes observed or expected in the surrounding area [e.g. land-use change, climate, environment],*
10. *industry to consider, in their risk analysis, the potential unavailability of safety barriers and lifelines due to natural hazard impact.*

## 8.4 Recommendations on Consideration of Climate Change in Natech Risk Management, Consideration of Natech Risks in Adaption to Climate Change (Session 3)

As stated in the previous Natech-I-workshop 2012, climate change is estimated to affect the intensity, frequency and geographical occurrence of a range of natural hazards. This means that facilities already subject to extreme meteo- and hydrological events may be the most affected.

It is challenging to transform the need for regulations that consider aspects of climate change into concrete actions. There are interesting developments, such as the integration of climate change into regulatory practice (ICCARP) in connection with the permitting practice according to the Industrial Emissions Directive (2010/75/EU) or the EU Directive (2014/52/EU), in which climate change should also be included in the Environmental Impact Assessment (EIA) as a part of permitting practice. However, at the moment, these lack concrete examples of implementation.

In practice, some internationally operating chemical enterprises already monitor changes for example in water-stressed areas, to evaluate how to adapt their facilities to the changes. This includes e.g. regular updates of emergency plans for extreme meteorological and hydrological events. As a recommendation, it would be desirable, if more operators took to this task.

At the same time, it surfaced during the UN/OECD Natech-II-Workshop that there is a need for information on the different adaptation measures that can be taken, in light of the expected impacts of climate change on natural hazards.

Considering climate change in Natech Risk Management, the following recommendations are listed in chapter 18 of the OECD Guiding Principles**:**

> *18.b.3. Management should be aware, and take account, of the fact that climate change may increase natural hazards. For example, climate change might affect the intensity, frequency and geography of natural hazards. Therefore, management should consider: assessing regional climate change projections; developing an adaptation strategy; implementing enhanced safety measures; and updating assessment and measures as further information becomes available.*

*18.d.2 When establishing land-use planning arrangements and policies related to hazardous installations, public authorities should take into account natural hazards such as floods, extreme temperatures, high winds, earthquakes, and wildfires as well as the possible impacts of climate change.*

In addition, the UN/OECD Natech-II-Workshop brought up three more recommendations:

11. *Consideration of climate change in regulations, licensing, permitting, and inspections for/of hazardous installations. This includes the definition of probabilities / intensities of natural hazards used for design of installations/facilities, the protection aims for the relevant installations and the requirement for protection measures.*
12. *Operators should stay informed of, interpret, and act upon information on local climate change. In this context, it has to be regarded to what extent climate change is already subject in the OECD Guiding Principles, the Sendai Framework, and the Words-into-Action Guide on man-made/technological Hazards.*
13. *Dissemination of information on kinds, effectiveness, and costs of adaptation measures for hazardous facilities due to the possible effects of climate change on natural hazards.*

## 8.5 Recommendations on Warning Systems, Natech Emergency Planning, Preparedness, and Response (Session 4)

In the 2012 Natech-I-Workshop it was recommended that "a specific Natural Disaster Response Plan [for a hazardous facility] may be useful and should be based on the careful evaluation of all possibilities to mitigate the effects of Natech accidents." and „Safety documents should consider the aspect of training staff to coordinate all activities in case of an extreme natural event."

In the survey in 2017, all respondents agreed that natural hazards are being considered in the drafting of emergency plans for hazardous sites or installations (question 15a), but only two are submitting good practice examples regarding this issue.

Considering warning systems, Natech emergency planning, preparedness, and response, the following recommendations are listed in chapter 18 of the OECD Guiding Principles:

*18.a.2 Adequate training should be provided to those responsible for preparing and using natural hazard maps in the context of, for example, siting of hazardous installations, land-use planning, designing and operating hazardous installations, and emergency planning.*

*18.f.1 Existing emergency plans should be reviewed to be sure they address the possible consequences of earthquakes, floods, extreme temperatures and other natural hazards that might trigger Natechs.*

*18.f.2 Natural hazard warning systems should be regularly tested, maintained, and updated to inform companies and communities of impending natural hazards or disasters, to the extent practicable.*

*18.f.3 Response personnel should be provided with available information to be most effective in addressing Natechs.*

Several early warning systems exist at the national or regional level, but fewer early warning systems exist at the local level.

14. *Local conditions and effects need to be considered in early warning systems to improve their value for operators of hazardous facilities.*

15. *The use of early warning systems by operators should be improved. Early warnings should be directly sent to endangered facilities.*
16. *The development of cross border early warning systems for natural hazards should be promoted.*
17. *Operators should be able to interpret early warnings and to decide what course of action to take in accordance with their safety management systems.*

## 8.6 Recommendations on Follow-Up of Events, Event Analysis, Recovery, Rehabilitation, and Reconstruction (Session 5)

At first glance, there should be no difference between follow-up of Natechs and other major accidents. In reality there are differences, e.g. where a Natech is caused by a long-lasting or severe natural disaster this may limit the resources of authorities to conduct a proper event analysis. However, according to the survey, Natech accidents are reported in case of natural disasters in 81% of the cases (question 21a). This means that even in cases of severe natural disasters, proper Natech analysis should be conducted.

Another aspect is that several natural hazards affect usually not only one part of a facility - they usually affect and may potentially destroy several, if not all parts. Similarly, it has to be considered after such an event, whether a change of the facility's location is useful. This applies even more when taking into account the routes of hurricanes, flood or earthquake prone areas and the locations of chemical and petrochemical industries. Consequently, not only the owners of facilities, but also the authorities should examine, whether those areas are suitable for productions using hazardous chemicals. The authorities are responsible for land-use planning and they should integrate Natech risks therein. Especially for the coastal areas it is of great importance to consider the consequences of the climate change (rise of sea level, intensity of storms and hurricanes, precipitation and flood etc.).

The following additional recommendations were made during the UN/OECD Natech-II-Workshop:

18. *In particular with respect to climate change, operators of hazardous facilities should not rely on individual employees' experiences with past events to predict future risk.*
19. *After a major Natech accident, there should be an assessment of reconstruction versus change of location.*

## 8.7 Recommendations on Transboundary and International Cooperation (Session 6)

International cooperation should be extended to support governments, authorities and operators in the implementation of effective Natech Risk Management. In the recommendations of the Natech-I-Workshop in 2012 it was pointed out that "a multi-stakeholder approach, including coordination between governments, is important for Natech Risk Management."

Considering transboundary and international cooperation, the following recommendations are listed in chapter 18 of the OECD Guiding Principles:

*18.g.1 Neighbouring countries[8] should cooperate in Natech prevention, preparedness and response.*

[8] Including riparian countries that share a transboundary watercourse.

*18.g.2 Countries should exchange experience concerning good practices for Natech prevention, preparedness and response including natural hazard identification, hazard mapping and natural disaster management.*

These general recommendations should be made more concrete. Numerous recommendations have already been proposed in connection with the other sessions. Since the elaboration of further guidance was seen skeptical during the UN/OECD Natech-II-Workshop, the recommendations for improved transboundary and international cooperation are as follows:

20. *States should work together including the drafting of transboundary natural hazard maps e.g. for international riverine systems.*
21. *Information on Natech accidents and Natech Risk Management should be made internationally available [e.g. on an online-based portal].*
22. *States should make use of the policy forums provided by international and regional organizations to continue to foster the exchange of experiences and good practices in Natech Risk Management.*
23. *Existing legal obligations, guidance and tools addressing Natech Risk Management should be implemented by governments, industry, authorities and practitioners.*
24. *There is a need for dedicated guidance on Natech Risk Management which should be developed, aimed at industry (management), authorities, policy-makers, and practitioners. Such guidance should build on existing legal obligations, guidance and tools addressing Natech.*

## 8.8 Recommendations on Natech Risks: Communication and Education (Session 7)

One important aspect in Natech Risk Management is the communication between all involved technical disciplines, industry and authorities. Furthermore, for construction of a Natech early warning system, informing the population is necessary.

Considering Communication and Education, the following recommendation is listed in chapter 18 of the OECD Guiding Principles:

*18.b.5 Management should maintain a dialogue with the public authorities with regard to the status of natural hazard assessments such as seismic zone maps and flood risk maps.*

Question 20 in the Natech survey in 2017 focused on the consideration of Natech risk in communication with the concerned neighborhood, the media, and the public. Only 25% of the responding countries replied that information provided to the public before siting or licensing of hazardous installations includes information on Natech Risks (question 20a). Meanwhile, only 38% of the respondents agreed that:

a) information provided to the potentially affected public on risks of hazardous installations includes information on Natechs Risks, if relevant (question 20c),
b) information provided to the potentially affected public in case of emergencies due to chemical accidents includes specific guidance for Natechs, if Natech risks are relevant (question 20e), and
c) experts for natural hazard risks are included in the process of communication with the public, if Natech risks are relevant (question 20f).

The answers indicate that there is a need for improvement of communication of Natech risks if they are relevant at hazardous facilities. E.g. maps provided by the industry to authorities and the neighborhood of their sites showing hazards due to chemical accident risks should include additional information on hazards caused by Natechs. Recommendations from the UN/OECD Natech-II-Workshop were:

25. *Where Natech risks exist, they should be included in the communication with the potentially affected neighbourhood, the media, and the public during siting, licensing, and preparedness activities.*
26. *In particular, information provided to prepare the potentially affected public for cases of emergencies due to chemical accidents, should include specific guidance for Natechs, if relevant.*
27. *Experts for natural hazard risks should be included in the process of communication with the potentially affected neighbourhood, the media, and the public, if Natech risks are relevant.*

In 2017 62% of respondents mention that, Natech Risks are considered in education or training of persons in charge of the safety of hazardous installations (question 22a). This result is not so bad when considering the small percentages that can be drawn from the questions on Natech risk communication. Furthermore, 75% of respondents mentioned that Natech risks are being considered in education or training of persons in charge of disaster (risk) management (question 22b). Nevertheless,

28. *There is a need to have more education and training for technical management of industry and public authorities in Natech Risk Management.*

On the issue of Natech research, it was furthermore recommended that:

29. *Successful research on Natech Risk Management needs an interdisciplinary approach including social sciences.*

## 8.9 Recommendations on Natech Risk Management in the Public Sector: Natech Risk Governance, Regulation, Enforcement, and Reduction (Session 8)

The multitude of tasks of the authorities is reflected in the numerous recommendations in chapter 18 of the OECD Guiding Principles:

*18.a.1 Public authorities should collect data related to natural hazards and natural disasters, and use this to develop natural hazard maps, which are important tools for the dissemination of information on natural hazards.*

*18.a.2 Adequate training should be provided to those responsible for preparing and using natural hazard maps, … land-use planning … and emergency planning.*

*18.a.3 Further efforts should be undertaken to improve the methodologies and tools for preparing hazard maps …*

*18.d.2 When establishing land-use planning arrangements and policies related to hazardous installations, public authorities should take into account natural hazards such as floods, extreme temperatures, high winds, earthquakes, and wildfires as well as the possible impacts of climate change.*

*18.d.3 Adequate training in Natech Risk Management should be provided to those responsible … land-use planning.*

*18.e.1 In developing and reviewing regulations and guidance concerning chemical accident prevention, preparedness and response, public authorities should take into account risks associated with Natechs.*

*18.f.2 Natural hazard warning systems should be regularly tested, maintained, and updated to inform companies and communities of impending natural hazards or disasters, to the extent practicable.*

*18.f.3 Response personnel should be provided with available information to be most effective in ad-dressing Natechs.*

*18.h.1 Countries should consider how to apply the Polluter Pays Principle in the context of chemical accidents triggered, or made worse, by natural hazards.*

The answers to question 9 of the survey in 2017 indicate, that Natech risks and Natech Risk Management are regulated in a lot of cases only on a general level. There may be a lack of guidance specific for Natech Risk Management and implementation of regulations on Natech risks. Regarding inspection systems and inspections, the survey shows that Natechs are also widely taken into account, but regulations or specific guidance are lacking in the majority of the cases. Since several recommendations from other sessions can be listed here as well, only one additional recommendation was made during the UN/OECD Natech-II-Workshop:

30. *Development, communication, dissemination and implementation of good practice examples (see recommendation 3) for effective Natech risk reduction.*

# 9 General Conclusions and Recommendations

This chapter includes six recommendations on possible further activities of the involved UN organizations, the OECD Working Group on Chemical Accidents, and the Natech project. They are based on the results of the survey, the discussion document, the evaluation of the abstracts, the discussions at the UN/OECD Natech-II-Workshop and the review of the UN/OECD Natech project steering group.

1. Natech Risk Management is regarded as an aspect of both Chemical Accident Prevention, Preparedness and Response, as well as of Disaster Risk Reduction. Hence, both related groups should be aware of the activities of the other. Therefore, cooperation is recommended in activities for Disaster Risk Reduction and for Chemical Accident prevention, preparedness and response, especially in:
    a) Development of rules or recommendations
    b) Development of guidance
    c) Support of their implementation

This is relevant for all aspects of Chemical Accident Prevention, Preparedness and Response, not only Natechs.

2. Awareness needs to be raised of the specific characteristics of Natech risks compared to other chemical accident risks, such as different causes, scenarios, and consequences.
3. Development, communication, dissemination, and implementation of good practice examples in Natech Risk Management may be useful, e.g. examples for
    a) regulations and guidance,
    b) siting of and land use planning for hazardous facilities,
    c) safety management at hazardous facilities,
    d) consideration of Natech risk in risk analysis for hazardous facilities [including in safety reports/documents and emergency plans],
    e) consideration of climate change in Natech Risk Management,
    f) consideration of natural hazards in special operation procedures for hazardous facilities [e.g. extreme weather conditions],
    g) design and construction of installations,
    h) consideration of Natech risks in inspection systems and inspections,
    i) enforcement of Natech risks management requirements at existing installations / facilities,
    j) cross boarder and international cooperation in natural hazard mapping and warning systems,
    k) education and training of staff of authorities and of hazardous facilities, and
    l) effective Natech risk reduction.

A database on these good practice examples should be accessible online.

4. On the basis of the results from both Natech Workshops and the identified good practice examples in Natech Risk Management, further guidance for Natech Risk Management should be elaborated. This may include guidance how to consider Natechs in:
    a) the development of policies, legislation, and regulations,
    b) siting of industrial facilities,
    c) risk analysis and assessment methods,

d) the elaboration and up-dating of safety documents (e.g. EU Seveso-Directive: safety reports),
e) emergency plans developed by operators of hazardous facilities,
f) joint emergency plans between neighboring or riparian countries,
g) transboundary cooperation on Natech Risk Management, and
h) transfrontier hazard communication and mapping.

This guidance may include general guidance and further guidance for special stakeholders or on special subjects, e.g. the guidance on Natech Risk Management in industry may include a section for corporate governance and for technical management.

The Natech Steering Group shall elaborate a structure and an outline for this guidance considering the existing guidance on Natech Risk Management in the OECD Guiding Principles.

5. The UN/OECD Natech-II-Workshop contributions showed different levels in Natech Risk Management of the stakeholders in different countries. There is a need to improve the communication on research on and implementation of Natech Risk Management tools. Especially cross-border and international cooperation should be supported by international organizations, governments, and industry.

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# 11 List of Annexes

- Annexe I: Record of Good Practice Examples in Natech Risk Management
- Annexe II: Questionnaire of the Survey 2017

# 12 Annex I: Examples of Good Practice in Natech Risk Management

The record is to be published separately.

# 13 Annex II: Questionnaire of the Survey 2017

**Survey on Natech (Natural Hazard Triggered Chemical Accidents)**
**Risk Management**

The purpose of this survey is:

1. to assess Natech risk management practices and awareness of Natechs,
2. to identify needs and/or limitations in implementing Natech risk reduction strategies, and
3. to identify examples of good practices in Natech Risk Management.

This questionnaire supports the OECD Working Group on Chemical Accidents Project on Natech Risk Management. The results of the survey shall give examples of good practices in Natech Risk Management and will therefore lead to better designed and targeted Natech risk reduction strategies. A report based on the evaluation of the answers to this questionnaire will be provided to the OECD Working Group on Chemical Accidents.

The results from the evaluation of the answers and the examples on good practices in Natech Risk management shall be presented at an OECD/UN Natech Workshop planned for 2018.

Needless to say, the success of this survey depends on your contribution. Thus, it is important that you answer each question in as complete a way as possible. **We understand that sometimes the information may not be available or not in the level of detail required by the question. In this case, please answer the question to the best of your ability.** If you want to provide additional information or need more space to explain your answers please feel free to add as much information as you need.

**This questionnaire is absolutely confidential.**

All presentations of the results of this survey will represent data anonymously. Access to the completed questionnaire will be restricted to the secretariat of the OECD Working Group on Chemical Accidents and the Natech-project steering group only.

If you have any questions on the questionnaire please contact the project leader Mr. Roland Fendler, UBA Germany (Roland.Fendler(at)uba.de).

Please send the completed questionnaire to the OECD Secretariat of the WGCA
(Ms. Marie-Ange BAUCHER at Marie-Ange.BAUCHER(at)oecd.org).

**Please complete your answers by Monday, 31.07.2017.**

*If you or your country or organisation answered the first survey on Natech Risk Management of the EC Joint Research Center/OECD in 2009 you may give only additional or up-dated information. Please note if there was no change since 2009.*

Please carefully read the following definition for "Natech" and "chemical accident":

A "Natech" is defined as a chemical accident, including spills of oil and oil products, triggered by a natural hazard or natural disaster (such as extreme temperatures, high winds, floods, storms, earthquakes, or wildfires).

*WE ASK NATIONAL AUTHORITIES TO ANSWER FOR THEIR COUNTRY, AND INDUSTRY, INTERNATIONAL ORGANIZATIONS AND OTHER STAKEHOLDERS FOR THEIR ORGANIZATION WHERE APPLICABLE*

# I. Regulations for the Prevention and Mitigation of Natechs

## 1. Regulations and guidelines for chemical-accident prevention and mitigation

a) Which government institution(s) in your country oversee(s) chemical-accident prevention and mitigation? Please provide a brief description of their responsibilities.
*(Note: If there is more than one institution, please list them and their responsibilities.)*

| Institution | Responsibilities |
|---|---|
| | |

b) Please indicate which rules, codes or guidelines (incl. international agreements) are used in your country to regulate or guide *hazardous-substances* production, use or storage in order to prevent or mitigate chemical accidents with impacts on the public and/or the environment.

| Issued by (year) | Rule, Code, Guideline |
|---|---|
| | |

c) Do any of these rules, codes and/or guidelines address the *natural hazards* your country is susceptible to? ........................................................................................................**Yes** ☐ **No** ☐

If yes, please indicate title and year of the applicable document, type of natural hazard(s) considered, and how day-to-day hazardous-substances handling is affected (e.g. no chemical storage facilities in floodplains or seismic zones, etc.):

| Title and year of document | Natural hazard(s) considered | Impact on hazardous-substances handling |
|---|---|---|
| | | |

d) Does your country/organization have a document which provides guidelines *specific* for Natech risk management? ..........................................................................................**Yes** ☐ **No** ☐

If yes, please indicate title and year of document and indicate for which natural hazard(s):

| Title and year of document | Natural hazard(s) considered |
|---|---|
| | |

e) Is your country/organization developing a strategy or program to address the problem of Natech events?..........................................................................................................**Yes** ☐ **No** ☐

If yes, for which natural hazard(s): …………………………………………….

f) Could one of these rules, codes, guidelines, technical codes, standards, strategies or programs be an example of good practice in Natech Risk Management? ..................**Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ……..........................................................................................

## 2. Effectiveness of regulations

a) In your opinion has your country's approach to chemical-accident prevention and natural-disaster management been effective in preventing Natech accidents? *Please indicate the level of effectiveness (1, low or not effective, and 5, high effectiveness).* Please choose a value.

b) Are there any gaps or shortcomings in your country's rules or codes that should be addressed to ensure effective Natech risk reduction? ......................................................**Yes** ☐ **No** ☐

If yes, please explain: ………………………………………………………………

c) Has there been an amendment in your country's rules or codes considering the publication of the Natech Addendum to the OECD Guiding Principles? ........................................ Yes ☐ No ☐

## II Natech Events Data Collection and Retrieval

### 3. Database or Records for Chemical Accidents

Does your country/organization maintain a database which can be used to record and retrieve information on chemical accidents? ........................................................................................ **Yes** ☐ **No** ☐

If yes, please describe (name of database, owner, access): ..........................

If yes, can this database be used to identify and retrieve information on Natechs? .... **Yes** ☐ **No** ☐

## III Natech Awareness and Risk Reduction

If you answered these questions in 2009 please do that again according to the actual situation. This may allow to estimate how much progress was made since 2009.

### 4. Statements on Natech Awareness and Risk Reduction

Please answer the items below by marking the box at the end of each item that best reflects your opinion.

| A Disagree Strongly | B Disagree Slightly | C Neutral | D Agree Slightly | E Agree Strongly | A | B | C | D | E |
|---|---|---|---|---|---|---|---|---|---|
| a) Risk managers/ safety professionals in industry in my country/organization are aware of the concept of Natechs. | | | | | ☐ | ☐ | ☐ | ☐ | ☐ |
| b) Natech events are discussed among those in charge of chemical-accident prevention and mitigation in my country/organization. | | | | | ☐ | ☐ | ☐ | ☐ | ☐ |
| c) Natechs events are discussed among those in charge of natural-disaster management in my country. | | | | | ☐ | ☐ | ☐ | ☐ | ☐ |
| d) There is enough emphasis on Natech risk reduction in the laws and regulations for chemical-accident prevention and mitigation. | | | | | ☐ | ☐ | ☐ | ☐ | ☐ |
| e) There is adequate knowledge on the dynamics of Natechs among our country's competent authorities. | | | | | ☐ | ☐ | ☐ | ☐ | ☐ |
| f) The relevant competent authorities in my country have adequate training on Natech risk reduction to enable effective Natech risk management. | | | | | ☐ | ☐ | ☐ | ☐ | ☐ |
| g) Current practices for chemical-accident prevention and mitigation in my country/organization provide for adequate protection of citizens against possible Natech events. | | | | | ☐ | ☐ | ☐ | ☐ | ☐ |
| h) Current industry risk assessment methods adequately take into consideration Natech events. | | | | | ☐ | ☐ | ☐ | ☐ | ☐ |
| i) The design and construction of buildings and other structures in industry according to the adopted building codes in my country provide sufficient protection against Natech accidents. | | | | | ☐ | ☐ | ☐ | ☐ | ☐ |

### 5. Recommendations on Natech Risk Reduction

In order to further reduce your country's or organization's susceptibility to Natechs, what would be your top <u>three</u> Natech risk reduction strategies/recommendations? Please list: ........................

## IV Consideration of Natural Hazards and Natech Risks

### 6. Natural Hazard Mapping

a) Are there natural hazards maps in your country? ...................................................... **Yes** ☐ **No** ☐

b) If Yes, which type(s) of hazards do they consider?

c) If Yes, which scope do they cover (National, regional, local)?

d) If Yes, are operators of hazardous installations involved in drafting and amendment?

Please use the table for your answers to allow simple evaluation of the answers:

| Natural Hazard Maps | Scope | | | |
|---|---|---|---|---|
| Hazards Considered | National | Regional | Local | Involvement of operators |
| ☐ Geological[9]: ……………………………… | ☐ | ☐ | ☐ | ☐ |
| ☐ High winds[10]: ……………………………… | ☐ | ☐ | ☐ | ☐ |
| ☐ Floods[11]: …………………………………… | ☐ | ☐ | ☐ | ☐ |
| ☐ Extreme temperature and related[12]: ……… | ☐ | ☐ | ☐ | ☐ |
| ☐ Other[13] (specify): ………………………… | ☐ | ☐ | ☐ | ☐ |

e) Could one of these kind of maps be an example of good practice? ........................**Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ……..........................................................................................

**7. Natural Hazard[14] and Multi-Hazard[15] Early Warning Systems**

a) Are there natural hazard early warning systems in your country? ........................**Yes** ☐ **No** ☐

b) Are there multi-hazard early warning systems in your country? ............................**Yes** ☐ **No** ☐

c) Which type(s) of hazards do they consider?

d) Which scope do they cover (National, regional, local)?

e) Are operators of hazardous installations involved in their development?

f) Do operators of hazardous installations use these early warning systems for their emergency management?

Please use the table for your answers to allow simple evaluation of the answers:

| Warning Systems | Scope | | | | |
|---|---|---|---|---|---|
| Hazards Considered | National | Regional | Local | Involvement of Operators | Used by Operators |
| ☐ Geological: …………………….. | ☐ | ☐ | ☐ | ☐ | ☐ |
| ☐ High winds: ……………………. | ☐ | ☐ | ☐ | ☐ | ☐ |
| ☐ Floods: ………………………….. | ☐ | ☐ | ☐ | ☐ | ☐ |
| ☐ Extreme temperature and related: | ☐ | ☐ | ☐ | ☐ | ☐ |
| ☐ Other (specify): ………………… | ☐ | ☐ | ☐ | ☐ | ☐ |

[9] Like: Earthquake, Volcano, Landslide, Tsunami, Subsidence

[10] Like: Storm, Thunderstorms, Tornado

[11] Like: Flash flood, River flood, Storm surge, “urban floods”

[12] Like: Heat, Cold, Snow, Ice, Drought

[13] Like: Heavy rain, Lightning, Wildfire

[14] **Early warning system:** An integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication and preparedness activities systems and processes that enables individuals, communities, governments, businesses and others to take timely action to reduce disaster risks in advance of hazardous events. See: http://www.preventionweb.net/drr-framework/open-ended-working-group/

[15] **Multi-hazard early warning systems** address several hazards and/or impacts of similar or different type in contexts where hazardous events may occur alone, simultaneously, cascadingly or cumulatively over time, and taking into account the potential inter-related effects. A multi-hazard early warning system with the ability to warn of one or more hazards increases the efficiency and consistency of warnings through coordinated and compatible mechanisms and capacities, involving multiple disciplines for updated and accurate hazards identification and monitoring for multiple hazards.

g) Could one of these early warning systems be an example of good practice? ....**Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ……..............................................................................

**8. International Cooperation in Mapping and Early Warning Systems**

a) Is there transboundary or international co-operation in the development of natural hazard maps? ........................................................................................................................................**Yes** ☐ **No** ☐

b) If yes, which countries and authorities cooperate in which type of maps? Please list: ……………

c) Is there transboundary of international cooperation in the development of natural hazard early warning systems? ..................................................................................................**Yes** ☐ **No** ☐

d) If yes, which countries and authorities cooperate in which type of systems? Please list: …………

e) Could one of these co-operations be an example of good practice?........................**Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ……..............................................................................

**9. Natural Hazards in Safety Management**

a) Are natural hazards taken into consideration in safety management at hazardous installations? Yes ☐ No ☐

b) If yes, could one case be good practice in Natech Risk Management? ....................Yes ☐ No ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ……..............................................................................

**10. Natural Hazards in (Operating) Procedures for Installations or Sites**

a) Are Natural Hazards considered in operating procedures? ........................................Yes ☐ No ☐

b) Are there special operating procedures for impacts of natural hazards (e.g. special operating procedures in case of cold, heavy rain, high winds)? ......Yes ☐ No ☐

c) Could one of these procedures be good practice in Natech Risk Management? Yes ☐ No ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ……..............................................................................

**11. Natural Hazards in Siting and Land-Use-Planning**

a) Are Natural Hazards considered in the choice of sites or in land-use-planning of areas for new hazardous installations? ..................................................................................Yes ☐ No ☐

If yes, which types of hazards are considered? Please list them: …………………....

b) Are new installations sited in natural hazard risk areas (e.g. presented in maps according to question 3.4.1)? ...........................................................................................................Yes ☐ No ☐

If yes, is there an evaluation of these hazards or a special risk analysis made? ...........Yes ☐ No ☐

c) Could one of these evaluations/analyses be good practice in Natech Risk Management? Yes ☐ No ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ……..............................................................................

**12. Natural Hazards in Risk Analysis**

a) Are natural hazards considered in Risk Analysis for hazardous installations? ..**Yes** ☐ **No** ☐

b) Are Natech risks considered in the mapping of risks identified by these analyses? **Yes** ☐ **No** ☐

c) Could one of these analyses be good practice in Natech Risk Management? ....... **Yes** ☐ **No** ☐

d) If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ..........................................................................................

**13. Natural Hazards in Design and Construction**

a) Are natural hazards considered in the design and construction of hazardous installations? **Yes** ☐ **No** ☐

If this is done on the basis of technical codes or standards please list them: ..........

b) Are the special risks of hazardous installations taken into consideration in these codes and standards (e.g. by increased design requirements)? ................................................ **Yes** ☐ **No** ☐

c) Could one of these procedures, codes or standards be good practice in Natech Risk Management? ........................................................................................................................ **Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ..........................................................................................

**14. Natural Hazards in Safety Reports / Safety Documents**

a) Are natural hazards considered in safety reports/documents? .................................. **Yes** ☐ **No** ☐

If yes, in which part of the safety report/document?

| | | |
|---|---|---|
| 1. | Information on the management system | ☐ |
| 2. | Presentation of the environment of the establishment | ☐ |
| 3. | Description of the installation | ☐ |
| 4. | Identification and accidental risks analysis and prevention methods | ☐ |
| a) | Description of the possible major-accident scenarios and their probability | ☐ |
| b) | Assessment of the extent and severity of the consequences of identified major accidents | ☐ |
| c) | Review of past accidents and incidents | ☐ |
| d) | Description of technical parameters and equipment used for the safety of installations | ☐ |
| 5. | Measures of protection and intervention to limit the consequences of a major accident | ☐ |

b) Could one of these safety reports/documents be good practice in Natech Risk Management? **Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ..........................................................................................

**15. Natural Hazards in Emergency plans**

a) Are natural hazards considered in the drafting of emergency plans for hazardous sites or installations? ........................................................................................................ **Yes** ☐ **No** ☐

b) Could one of these emergency plans be good practice in Natech Risk Management? **Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ..........................................................................................

**16. Consideration of Climate Change**

a) Is climate change considered in the Risk Analysis for hazardous installations? **Yes** ☐ **No** ☐

b) If yes, could one of these analysis be good practice in Natech Risk Management? **Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ..........................................................................................

c) Are risk analyses or emergency plans reviewed and updated – if necessary –to consider climate change? ....................................................................................................... **Yes** ☐ **No** ☐

### 17. Natechs and Climate Change in Licensing

a) Are Natech Risks or Climate Change considered in the licensing of hazardous installations? **Yes** ☐ **No** ☐

If this is done on the basis of regulations or specific guidance, please list them: ……………….

b) Could one of these regulations or guidance be good practice in Natech Risk Management? **Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ……………………………………………………………………………

### 18. Natechs in Inspections Systems and Inspections

a) Are Natech Risks considered in inspections? ………………………………………………………**Yes** ☐ **No** ☐

If this is done on the basis of regulations or specific guidance please list them: ……

b) Could one of these inspection systems or plans, regulations or guidance be good practice in Natech Risk Management?……………………………………………………………………………**Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ……………………………………………………………………………

### 19. Consideration of Natech risks at Existing Installations / Sites

a) Are Natech Risks considered at existing sites or installations? ……………………………**Yes** ☐ **No** ☐

b) Could one of these regulations or guidance be good practice in Natech Risk Management?**Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ……………………………………………………………………………

c) Is there any experience with retrofitting of installations to design requirements or to increased design requirements due to natural hazards? ……………………………………**Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: ……………………………………………………………………………

### 20. Consideration of Natech Risks in Risk Communication

a) Does the information provided to the public before siting or licensing of hazardous installations include information on Natech Risks? ………………………………………………**Yes** ☐ **No** ☐

b) Are Natechs considered in determining the public who might be affected in the event of an accident? ……………………………………………………………………………………………**Yes** ☐ **No** ☐

c) Does the information provided to the potentially affected public on risks of hazardous installations include information on Natechs Risks, if relevant? ……………………………**Yes** ☐ **No** ☐

d) Do the risk maps used in this communication include the mapping of Natech risks, if relevant? ……………………………………………………………………………………………**Yes** ☐ **No** ☐

e) Does the information provided to the potentially affected public in case of emergencies due to chemical accidents include specific guidance for Natechs, if relevant? ………**Yes** ☐ **No** ☐

f) Are experts for natural hazard risks included in the process of communication with the public, if Natech risks are relevant? ……………………………………………………………**Yes** ☐ **No** ☐

### 21. Natechs in Follow-Up of Natural Disasters

a) Are Natech accidents reported in case of natural disasters? ……………………………**Yes** ☐ **No** ☐

If yes, which authority/authorities collects these reports? ……………………………………

b) Which information on the effects of these Natechs is included in these reports?

fatalities ☐ Health ☐ Environment ☐ Economy/economic damage ☐

c) Is there an analysis of the causes of and lessons to be learnt from these Natechs? **Yes** ☐ **No** ☐

If yes, which authority/authorities collects the results of the analysis? ………………

## 22. Natechs in Education and Training

a) Are Natech Risks considered in education or training of persons in charge of the safety of hazardous installations? ........................................................................................................**Yes** ☐ **No** ☐

If this is done on the basis of regulations or guidance please list them: ……………..

b) Are Natech Risks considered in education or training of persons in charge of disaster (risk) management? ......................................................................................................................**Yes** ☐ **No** ☐

If this is done on the basis of regulations or guidance please list them: ……………...

c) Could one of these regulations or guidance be good practice in Natech Risk Management?**Yes** ☐ **No** ☐

If yes, please provide more information, e.g. submit a copy of or provide links to relevant documents: …….......................................................................................

## V Background Information

In order to analyze the data it is important that we have some background information so that we can group opinions together.

**We would like to remind you that all responses are completely confidential**.

### 23. Contact information

Contact information of the person filling in the questionnaire:

| |
|---|
| Name: |
| Organization: |
| Country: |
| Address: |
| Phone: |
| Email: |

### 24. Natech Awareness

Were your aware of the concept of Natechs before taking this survey?........................ **Yes** ☐ **No** ☐

### 25. Affiliation

Your organization belongs to:

**a. Public sector** ☐

Please indicate in which area your organization's responsibilities mainly fall in:

Please choose from the list.

**b. Private sector** ☐

*Please indicate in which area your organization's responsibilities mainly fall in:*

Please choose from the list.

**c. Your organization is at which level:**

Please choose from the list.

### 26. Process to Answer the Questionnaire

What process did you use to complete the answers to this survey (please check all that apply)?

☐ To answer some questions I used my own knowledge from ............years of work experience.

☐ I discussed several/all questions with different colleagues individually.

☐ I had to look through our records to answer some of the questions.

☐ The questions and answers were discussed in a meeting.

☐ Other (please specify): ......................................