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Executive summary

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Climate Change and Safety of Installations: Recommendations from the UN/OECD-Natech Project

Executive summary

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1 Climate change and relevant natural hazards

This paper deals with the expected impacts of climate change[1] on the frequency and intensity of natural hazards and their impacts on installations where hazardous substances are present[2]. It is assumed that (1) high-temperature periods (hot days and tropical nights) can lead to an increase in the temperature of installations and substances. (2) Dry periods may cause forest and vegetation fires at or in the vicinity of installations and may act as a source of ignition and may cause unintentional heating of plant components and substances. (3) Heavy precipitation, flash floods or river floods can cause flooding so that installations are impaired by moisture, buoyancy, flow forces and flotsam. (4) The rise in sea level in connection with storm surges may lead to flooding as well as to the influence of moisture, buoyancy, current forces and flotsam on installations. (5) Winter storms may increase the wind loads on the installations and thus impair the installations by pressure, suction, vibrations, deformation and flying debris. (6) Lightning acts on installations as an ignition source as well as through electromagnetic radiation and flying sparks and (7) hail may hit installations as projectiles and hail may act as a "snow load" on installations, while (8) tornadoes can cause damage through pressure and suction forces as well as flying debris.

According to the current state of knowledge, the following effects of climate change in Germany on natural hazards are to be expected or are possible:

Table 1: Effects of climate change on natural hazards in Germany

Possible hazard	possible effects on operational areas	Changes due to climate change[3]				
		intensities	frequencies	duration	expected	possible
High Temperature Periods (Hot Days and Tropical Nights)	Increasing the temperature of installation components and substances	⇧	⇧	⇧	✓	
Dry periods	Forest and vegetation fires in or near operating areas: source of ignition, heating of installation components and substances	⇔	⇧	⇔	✓	
Heavy precipitation / "flash floods"	Flooding and runoff: moisture, buoyancy, flow forces and flotsam affect installation components	⇧	⇧	⇔	✓	

[1] The information given on effects of climate change are valid for Germany only. They may be different for other countries.

2 This refers to establishments subject to the Major Accidents Ordinance (Störfall-Verordnung and Seveso-Directive (2012/18/EU).) and installations subject to licensing under Immission Control Act in which hazardous substances are present or intended to be present or will be present accordingly (in accordance with § 3 Paragraph 5a of the Federal Immission Control Act). Thereafter "installations".

3 ⇧ increase; ⇔ no changes expected; ? Knowledge insufficient for a statement; ✓ Classification of the state of knowledge

Possible hazard	possible effects on operational areas	Changes due to climate change[3]				
River flood	Flooding and runoff: moisture, buoyancy, flow forces and flotsam affect installation components	⇧	⇧	⇧	✓	
Sea level rise (higher rise of storm surges)	Flooding, wave impact: moisture, buoyancy, flow forces and flotsam affect installation components	⇧	?	⇧	✓	
Winter storms	Wind loads on plant components (pressure, suction, vibrations, deformation), debris flight	?	?	?		✓
Convective events/thunderstorms		⇧	⇧	?	✓	
Lightning	Ignition source, electromagnetic radiation, flying sparks		⇧			✓
Hail	Influence on plant components, snow load on installation components	?	⇧	?	✓	
Tornados	Pressure and suction forces, impact by flying debris	⇧	?	?		✓

2 Climate change and relevant natural hazards

The paper's recommendations are as follows: Operators of installations (where hazardous substances are present) should take into account natural hazards that may cause Natural Hazard Triggered Technological Accidents (Natechs) and the expected impacts of climate change on intensity, frequency and local distribution on these natural hazards. To this end, they will take into account projections of climate change, develop adaptation strategies to climate change, take further safety measures and update assessments and measures as new knowledge becomes available. Natural hazard maps should be drawn up by the authorities for all relevant natural hazard sources and these should be actively communicated to the relevant communities, citizens and operators of the installations and passively communicated via central portals on the internet. In addition, the natural hazard maps are to be expanded to include reliable scientific findings on the future development of natural hazards, particularly due to climate change. Irrespective of this, operators of installations should - on their own initiative - collect and take into account information about the expected change in natural hazards - including due to climate change - at their respective location. In the meantime, both operators and authorities should actively seek communication with each other when drawing up and updating natural hazard maps. When implementing the Major Accidents Ordinance for upper-class establishments, operators and authorities should pay attention to a methodical procedure for hazard source analysis in accordance with Annex II, Paragraph III, No. 1 of the Major Accidents Ordinance that also takes into account expected changes due to climate change, where appropriate. Operators, authorities and scientists should develop simulation systems for flash floods in the area of installations in order

to obtain important findings for the selection and evaluation of measures for the prevention of hazards and for emergency response measures. In order to analyse Natech risks, operators and scientists are to further develop methods for hazard analysis (e.g. Rapid-N of the Joint Research Centre of the EU Commission). In addition, operators should use warning systems against natural hazards for their alarm and emergency response planning. As part of an update of the relevant Technical Rules (Technical Rules for Plant Safety (TRAS) 310 and 320), these warning systems should therefore be referred to and their use made mandatory. In addition, natural hazards, the effects of climate change on these hazards and Natech risks should be taken into account when operators and authorities update their alarm and emergency response plans, and the results of the update shall be coordinated. Employees in facilities should be informed about the dangers posed by natural events and Natechs and about the behaviour that is expected of them in the event of a natural hazard. In addition, there remains room for improvement in the sub-statutory regulations and the implementation of the Major Accidents Ordinance with regard to the consideration of natural hazards. In particular, Natech risks are to be taken into account in the training and further education of employees responsible for the authorities and operators of corresponding installations. With regard to the damage caused by Natechs, it must be made clear in the Environmental Damage Act and in the Environmental Liability Act that the operator of the installation in which the hazardous substances were present and caused the Natech must be liable. Finally, states and operators responsible for installations that may be affected by natural hazards should work closely together on Natech risk management and exchange good practice experiences.

Table 2: Recommendations

Recommendation for	Operators	Authorities	States	Academia
1. **Operators** of installations where hazardous substances are present shall take into account natural hazards that may cause Natechs and the expected impacts of climate change on their intensity, frequency and local distribution. To this end, they are to take into account projections of climate change, develop adaptation strategies to climate change, take further safety measures and update assessments and measures as further knowledge becomes available.	X			
2. **Authorities** shall draw up hazard maps for all relevant natural hazards.		X		
3. The competent **authorities** shall actively communicate these natural hazard maps to the relevant municipalities, citizens and operators of installations in which hazardous substances are present and passively communicate them via central portals online.		X		
4. As far as reliable scientific findings on the future development of natural hazards are available, in particular due to climate change, these shall be attached to the respective hazard maps by the competent **authorities**		X		
5. **Operators** of installations in which hazardous substances are present should - independently of this - collect and take into account information about relevant natural hazards and their expected change - also due to climate change - at the respective location.	X			
6. Both **operators** and **authorities** should actively seek communication with each other in the creation and updating of natural hazard maps.	X	X		
7. When implementing the Major Accidents Ordinance (for establishments of the upper class), **operators** and **authorities** shall pay attention to a methodical procedure for the hazard source analysis - in accordance with Annex II para. III no. 1 of the Major Accidents Ordinance - which - as far as reasonable - also takes into account expected changes due to climate change.	X	X		

Recommendation for	Operators	Authorities	States	Academia
8. **Operators**, **authorities** and **academia** are to develop simulation systems for flash floods in the area of installations in which hazardous substances are present, in order to obtain important findings for the selection and dimensioning of measures for accident prevention and hazard defence**.**	X	X		X
9. To analyse Natech risks, **operators** and **academia** should further develop hazard analysis methods (such as Rapid-N of the EC Joint Research Centre).	X			X
10. **Operators** must use natural hazard warning systems for their alarm and emergency response planning. Within the framework of an update of the relevant technical regulations (TRAS 310 and 320), these warning systems should therefore be referred to and their use made mandatory.	X			
11. **Operators** and **authorities** should take natural hazards, the effects of climate change on these and Natech risks into account when updating alarm and emergency response plans. Results of the update are to be co-ordinated between **operators** and **authorities**. Employees in installations where hazardous substances are present should be informed about the dangers of natural hazards and Natechs as well as their expected behaviour in the event of a natural hazard.	X	X		
12. In the implementation of the Major Accidents Ordinance and in the sub-statutory regulations, natural hazards should be considered more strongly and in more detail.	X	X		
13. Natech risks should be taken into account in the training and further education of public **authority** employees and **operators** of installations in which hazardous substances are present.	X	X		
14. The **Environmental Damage Act (Umweltschadensgesetz)** and the **Environmental Liability Act (Umwelthaftungsgesetz)** shall clarify, with regard to damage caused by Natechs, that the **operator** of the installation or establishment, in which the substances causing the damage were present, must be liable.		X	X	
15. **States** that may be affected by **the same** natural hazard should work closely together on Natech risk management. The same should apply to **operators** in different countries whose installations may be affected by **one** natural hazard.		X	X	
16. **States**, **operators** and authorities shall share good practice experiences in Natech risk management.	X	X	X	