Natech risks

Overview, lessons learned and outlook

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Joint Research Centre

Fire/explosions, Lightning, Oil terminal, 2022

- Lightning strike at crude oil tank
  - Lightning protection system available
- Fire/explosions (boilover) engulfing 4 tanks
  - Domino effect (strong wind, high flames, low separation distances)
- 16 fatalities (fire fighters)
- International help needed to fight the fire

Oil spill, Landslide, Oil pipeline, 2013

- Landslide ruptured an oil transport pipeline
  - Release of 11,000 barrels of oil into a river
  - Oil slick contaminated drinking water for over 80,000 residents
  - Spill in one of the world’s most biodiverse regions
- Transboundary impact
  - Oil slick in river transported into another river and into a neighboring country


Source: Petroecuador

Is Natech risk a real problem?

Source: xquinn@favpng.com

- About 2-6% of accidents in industrial accident databases were caused by natural hazards
- There is a reporting bias towards severe accidents - the real number of Natechs is higher
- **Natech accidents often have more severe consequences than conventional accidents**

Natech risk governance: status quo

- Natech is a technological risk (although the trigger is a natural hazard)
  - Technological risks have a risk owner who is responsible for managing Natech risk
  - Technological risk management focuses on prevention
- In the EU, the Seveso III Directive requires consideration of Natech risks
- National and international initiatives (e.g. OECD, UNECE, etc.) already implemented or launched

JRC support to Natech risk management

Forensic analysis and gap analysis

- Incident analysis for industry & critical infrastructure
- Lessons learned and recommendations
- Natech incident database: eNATECH

Natech risk analysis/mapping

- Identify Natech hotspots and screen for cascading risks
- Web-based system for rapid Natech risk analysis and mapping: RAPID-N

Risk governance and guidance

- Guidance on Natech risk management
- Natech risk management performance indicators
- Collaboration with OECD and UN

Capacity building

- Training workshops on Natech risk analysis and risk reduction
- Joint Natech risk-analysis case studies

Priorities for action identified via a survey of EU Member States and OECD Member Countries

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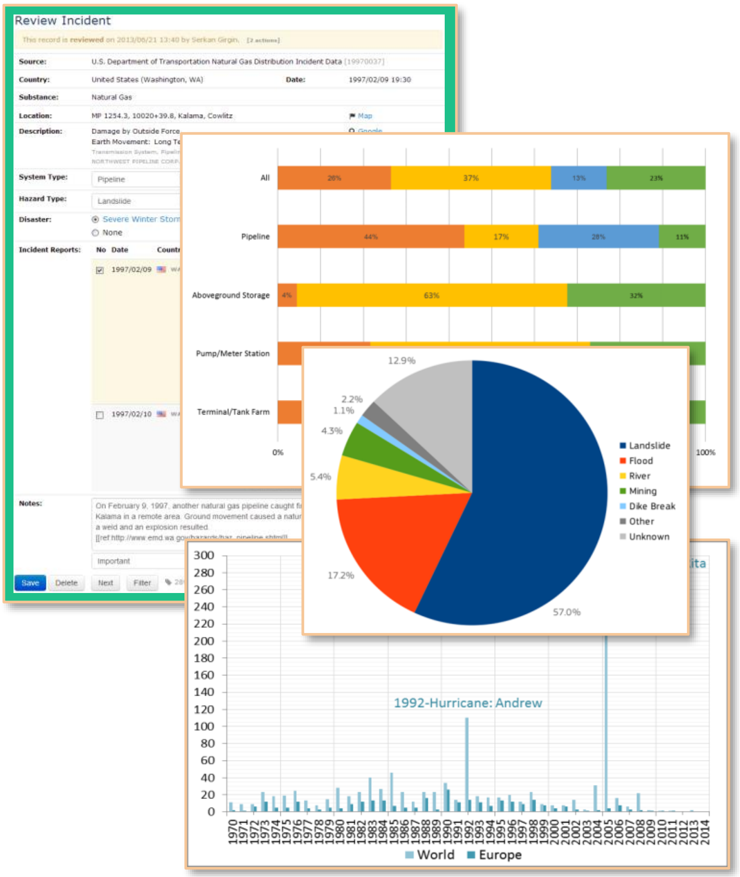
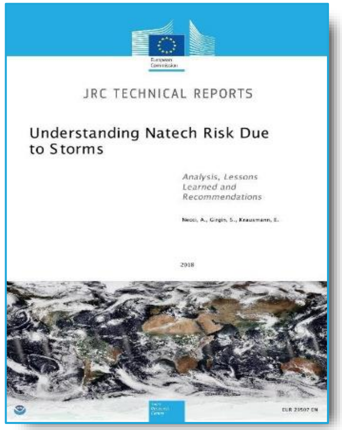
Forensic analysis and learning lessons

Objectives

- Revealing statistical trends
- Understanding dynamics of Natechs
- Identifying:
  - Root causes and contributing/exacerbating factors
  - Vulnerabilities and strengths
  - Consequences
  - Lessons learned and recommendations
- Preventing future accidents





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Accident analysis I

Earthquakes

- Damage/failure mechanisms:
  - Direct shaking impact
  - Ground deformation due to liquefaction
- Many simultaneous releases over large area
- Damage severity high (but: reporting bias!)
- High ignition probability (0.7) – increased risk of cascading effects

Photo: H. Nishi


Photo: E. Krausmann

Accident analysis II

Floods

- Damage/failure mechanisms:
  - Displacement due to buoyancy and water drag (water height & speed)
  - Impact of floating objects
- Floodwaters can distribute toxic or flammable substances over wide areas
- Toxic/flammable vapor formation due to reaction of chemicals with water (also in case of rain, tsunami)

Photo: U.S. EPA

Photo: U.S. Geological Survey

Example recommendations: earthquakes

Photo: A.M. Cruz

Rigid tank-pipe connections are a vulnerability:

Use flexible pipes or couplings

Photo: S. Girgin

Safety barriers can fail during earthquakes:

Use earthquake design also for critical safety barriers

Photo: U.S. Geological Survey

Don't build across or near fault zones:

If it cannot be avoided, use best earthquake engineering practice

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Example recommendations: floods

Empty or near-empty tanks can float during floods:

Use anchoring with bolts or other types of restraining systems

Flood-driven debris is an accident risk:

Use external barriers, e.g. containment walls, to protect equipment

Floods can affect emergency response:

Place safety-critical equipment outside the estimated inundation zone

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Natech risk analysis

1 Characterization of the natural hazard
2 Identification of critical equipment
3 Identification of damage severity/accident scenarios
4 Estimation of damage likelihood/probability (Equipment damage models)
5 Consequence evaluation of the accident scenario
6 Identification of credible combinations of events
7 Probability/likelihood calculation for each combination
8 Consequence calculation for each event combination
9 Risk integration

- Regardless of analysis approach chosen (qualitative or quantitative), extensions are necessary for Natech risk analysis
- The lack of equipment damage models for natural-hazard impact is currently the most serious limitation

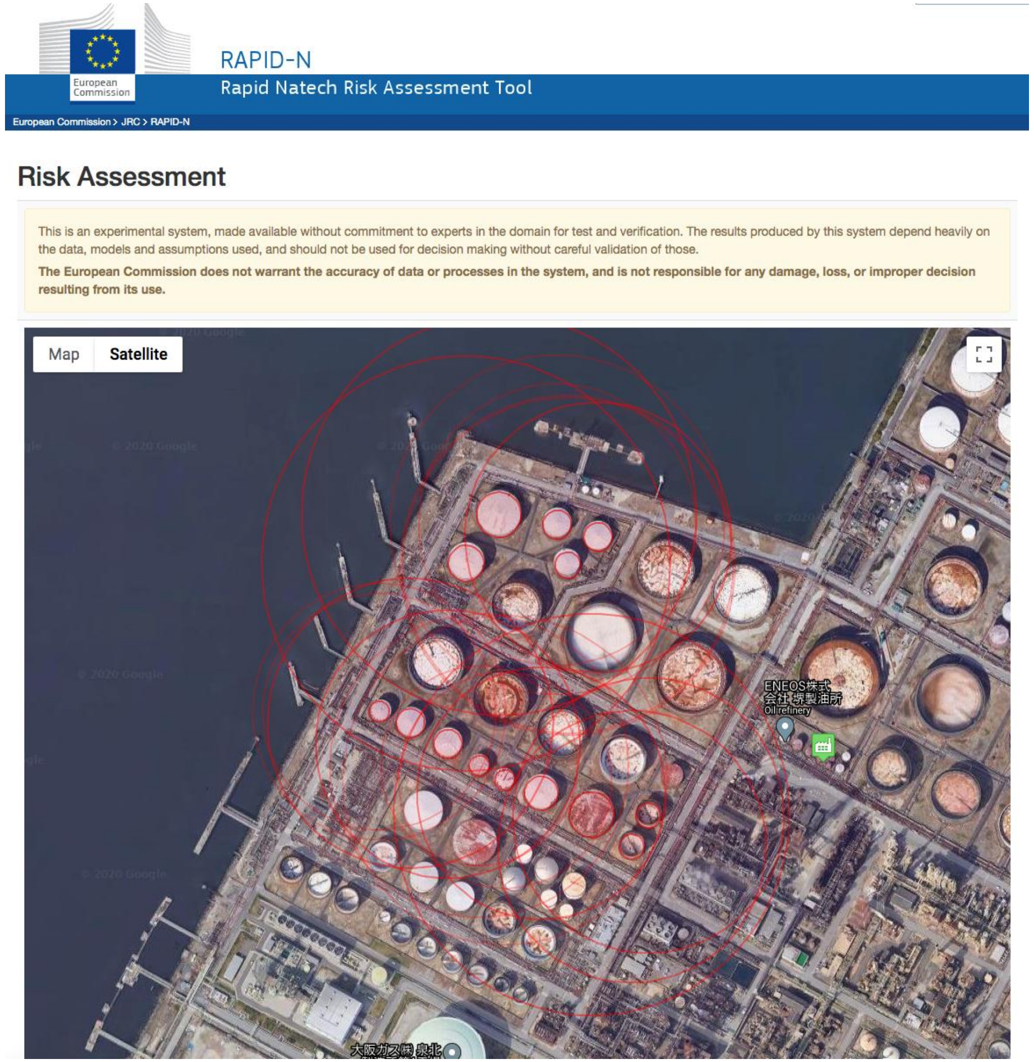
G. Antonioni, G. Spadoni, V. Cozzani (2007) A methodology for the quantitative risk assessment of major accidents triggered by seismic events, J. Haz. Mat. 147, 2007

Where are Natech hotspots and how high is the risk?

RAPID-N: Web-based, public JRC decision-support system for Natech risk analysis and mapping

- Unites natural-hazard assessment, damage estimation and consequence analysis in one tool!
- Users from >150 institutions globally

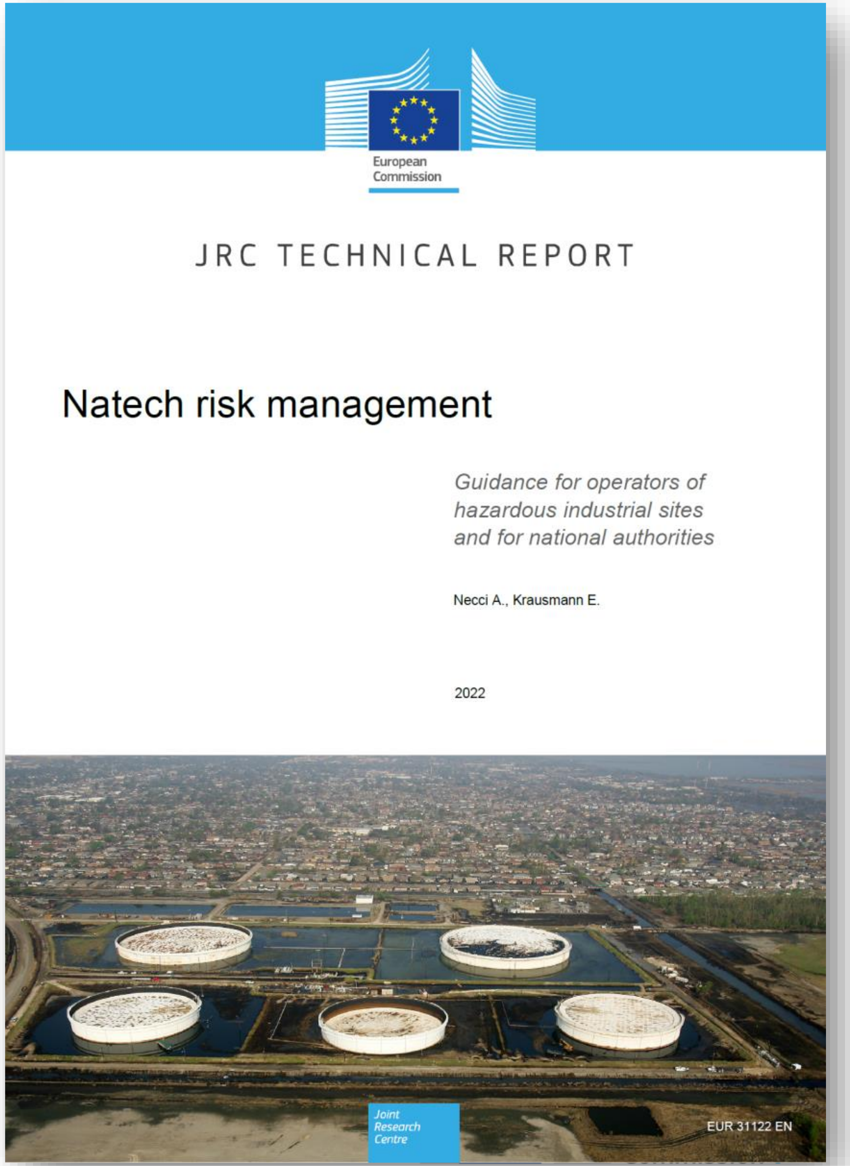
☞ **https://rapidn.jrc.ec.europa.eu**



Natech risk management

- For operators of hazardous sites and national authorities (focus Seveso)
- Step-by-step technical guidance on how to identify, analyse and treat Natech risks
- Focus on identification and modelling of specific scenarios for Natech risk assessment
- Translation to other language(s) underway

☞ *https://publications.jrc.ec.europa.eu/repository/handle/JRC129450*

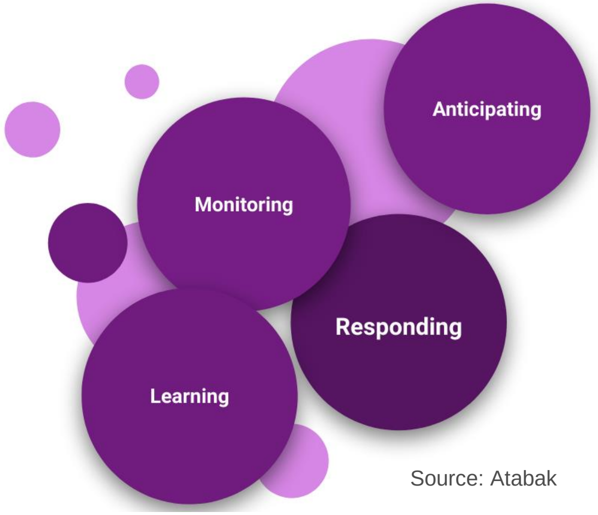


Closing the gaps I

Research and policy challenges persist that require action from regulators, industry and academia:

- Awareness
  - Recognize that industry is vulnerable to natural-hazard impact
    - *Vulnerability can also be linked to unavailability of lifelines and protection systems*
  - Understand limitations of the design basis (have a Plan B)
  - Natural hazards may be unforeseeable but their impacts are predictable (not a Black Swan!)
- Legal infrastructure
  - Risk reduction works best if required by law
  - Enact and enforce legislation for Natech risk reduction
- Risk assessment
  - Develop and improve methodologies and tools for Natech risk analysis and mapping (better damage functions; include environmental and economic impacts)

Closing the gaps II



Source: Atabak

- Risk governance and risk communication
  - Territorial perspective
  - Improve communication in industry and at all levels of government
  - Establish structures for information sharing, including access to risk-management competence and tools
- Data collection
  - Easy sharing of data on industrial risks, accidents and near misses for lessons learning (anonymization)
  - Data sharing between sectors and countries (e.g. eNATECH - **https://enatech.jrc.ec.europa.eu**)
- Knowledge and skills
  - Research to fill knowledge gaps
  - Stakeholder training (what to do in case of deviations from normal conditions?)
- Cooperation and partnerships
  - Industry, academia, authorities; local, regional and international networks to facilitate collaboration

Thank you

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