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Natural Hazards and Earth System Sciences

Postface

"From natural hazards to technological disasters"

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The last two years set a sad record in the number and scale of natural disasters and clearly demonstrated the high vulnerability of our modern society to the impact of natural events. In 2010 and the first semester of 2011 natural disasters killed more than 320 000 people across the world and economic losses soared to 320 billion US$ (CRED, 2011a, b).

A very serious secondary effect of natural disasters are so-called Natech accidents that take place when natural events trigger accidents at technological installations that house or process hazardous materials, such as nuclear power plants, chemical facilities, oil refineries or pipelines. One of the most large-scale Natech accidents occurred on 11 March 2011 in Japan as a result of a massive 9.0-magnitude earthquake off the northeast coast of Honshu Island, that reportedly caused a tsunami with a height of more than 30 m. With the total economic damages exceeding US$210 billion (CRED, 2011b), the Tohoku disaster is the most destructive on record. It caused a number of Natech accidents, including accidents at "Fukushima-1" and "Onagawa" nuclear power plants, explosions and fires at a refinery in Chiba and at a petrochemical plant in Sendai. It also damaged or destroyed many critical infrastructures (electrical power, water supply, communication), thereby resulting in supply disruptions, in addition to severely affecting transport of people and goods. These supply disruptions can hamper the smooth functioning of society through cascading events and can also adversely impact emergency-response operations that rely on the availability of lifelines.

A distinctive feature of natural-event impact on technological systems, such as during the 2011 Tohoku earthquake and tsunami, is their synergistic nature with a natural disaster resulting in the simultaneous occurrence of numerous technological accidents and disruptions. If not planned for, it is very difficult to deal with the consequences of such co-joint disasters, because one has to cope not only with the primary aftermath of the natural disaster, but also with the secondary effects of the triggered technological accidents, which can be extremely serious. The potential consequences are the more severe the higher the population density and concentration of industrial facilities and infrastructure (especially hazardous objects) in the disaster-affected areas.

In recent years, the number and severity of natural-event impact on technological systems are increasing all over the world. In many places nature put people and the technosphere to the test, with flood-triggered Natech accidents in Europe in 2002, Hurricanes Katrina and Rita and their impact on offshore oil- and gas production in the Gulf of Mexico in 2005, the Natech accidents in the wake of the 2008 Wenchuan earthquake in China, or the volcanic eruption in Iceland in 2010 that wreaked havoc on world air traffic and the forest fires in the Russian Federation that threatened a nuclear research centre and oil refineries. The more frequent occurrence of natural-event triggered technological accidents and disruptions is on the one hand due to the increase in the frequency of some natural hazards and changing precipitation patterns because of climate change, as well as a result of more industrialisation. On the other hand, the vulnerability of our society is increasing due to growing urbanisation that leads to encroachment on natural-hazard areas, and the complexity and interconnectedness of society.

The importance of these issues and a lack of research on the problem, compared with studies of natural hazards themselves, prompted us to organize a Special Session "Natural Hazards and Technological Disasters" at the General Assembly 2010 of the European Geosciences Union. The session dealt with the relationship between natural hazardous processes and the technosphere. The articles collected in this Special Issue are selected contributions to the session. They address a variety of topics including methodologies and tools for Natech risk assessment, procedures for loss

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estimations, case-study descriptions of Natech events and analysis of other natural-hazard impact on technological systems. Therefore, the main purpose of the Special Issue is to raise awareness of the increasing problem of natural hazards triggering technological disruptions and accidents and to propose methods and tools to mitigate the associated risk.

The article by Kepekci and Ozcep (2011) presents a contribution to earthquake disaster mitigation studies for selected cities in Turkey. The risk evaluation is based on earthquake hazard analysis and city information. A probabilistic seismic hazard analysis for each city was carried out using Poisson probabilistic approaches. The authors propose to evaluate the risk level of each city using the number of houses, the per-capita income of city residents, population, and ground motion levels. The five most risky cities were found to be, in descending order of risk, Istanbul, Izmir, Ankara, Bursa, and Kocaeli. The presented approach can also be applied to industrial facilities.

The study by Krausmann et al. (2011) discusses the efforts that are underway in the frame of the European FP7 project iNTeg-Risk with respect to the development of dedicated methodologies and tools for Natech risk management. Special attention is thereby given to the risk of chemical accidents triggered by earthquakes, floods and lightning. This work outlines the ongoing efforts in the development of new concepts and tools for Natech hazard and vulnerability ranking, risk assessment, risk-based design, and emergency planning and early warning.

The 17 August 1999, Kocaeli earthquake is the subject of the article by Girgin (2011). Among the many Natechs that occurred due to the earthquake, the massive fire at the TUPRAS Izmit refinery and the acrylonitrile spill at the AKSA acrylic fiber production plant were of particular importance and severity. They highlight problems in the consideration of Natechs in emergency planning, response to industrial emergencies during natural hazards, and communication to the public during and following the incidents. The analysis of these events shows that even the largest and seemingly well-prepared facilities can be vulnerable to Natechs if risks are not considered adequately.

Grimaldi et al. (2011) show the application results of an improved version of RST (Robust Satellite Technique) to maritime oil spill detection and monitoring. The proposed approach has been applied to the case of oil spills off the Kuwait and Saudi Arabian coasts in January 1991 and during the Lebanon War in July 2006. It is equally applicable for detecting oil spills caused by hurricanes and other storms, e.g. in the Gulf of Mexico. The technique demonstrates a high level of reliability and sensitivity in automatically detecting the presence of oil spills. The authors propose potentially using the technique with the sensors aboard geostationary satellites within the oil spill monitoring systems, thereby integrating products of high temporal (optical) and high spatial (radar) resolution satellite systems.

The article by Ozunu et al. (2011) highlights the Natech problem on the example of Romania. The research is based on a survey conducted by the Romanian competent authorities for the Seveso II Directive in the frame of an EU-wide Natech questionnaire survey by the European Commission's Joint Research Centre. This survey enabled the identification of Natech hazards and their correlation with the vulnerability of local communities and infrastructures. The Natech hazards were analyzed also in terms of their inclusion in the emergency-planning process, starting from the current legislation. The results indicate that the number of incidents (including Natech events) has significantly decreased subsequent to the appropriate implementation of emergency plans and safety reports.

Tools to avoid disasters at trunk pipelines in areas with active faults are the subject of the contribution by Besstrashnov and Strom (2011). They conclude that the relevant accuracy of localisation and characterisation of active faults capable of surface rupturing can be achieved solely by using direct evidence of fault activity. This differentiation requires strict definition of what can be classified as "active fault" and the normalization of methods used for their identification and localisation. This is of high significance considering the intensive development of new oil and natural gas fields in seismically active regions of Russia and other countries of the former Soviet Union.

The study by Petrova (2011) deals with a broader range of technological accidents and disasters induced by natural events than the "classical" Natech risk concept does. It also includes natural-event impacts on non-chemical critical infrastructures, industrial, and transport facilities causing accidents, failures, and crashes. The main purpose of this study is to identify the type and frequency of the natural causes that trigger technological accidents and disasters in Russia, to determine their proportion among the other non-natural causes of accidents, and to trace regional differences in their manifestation using an electronic data base.

The last paper by Frolova et al. (2011) presented a procedure for estimating the losses caused by strong seismic events and secondary hazards, such as Natechs, within a GIS environment. Examples of individual seismic risk zoning at Russian federal and regional levels are given, and the consequences of scenario earthquakes taking into account secondary technological hazards are estimated.

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