PEC

Post-Emergency, multi-hazard health risk assessment in Chemical disasters

June 2016.01

Greetings!

Welcome to the first newsletter of our project. PEC stands for Post-Emergency, Multi-Hazard Health Risk Assessment in Chemical Disasters. PEC is a 24 months project started in January 2016 and funded by Directorate-General Humanitarian Aid And Civil Protection (DG ECHO) of the European Commission under the prevention and preparedness program in the framework of the Union Civil Protection Mechanism.
In this newsletter we would like to introduce ourselves and our project, provide you with some background material and explain our ways of working. Most importantly, we would like to encourage all interested parties to support us in our endeavour and to constructively collaborate in achieving these results for the benefit of society as a whole. We hope that you find this information useful, and we are looking forward to hearing your feedback.

What is PEC?

PEC is a prevention and preparedness project funded by the Directorate-General Humanitarian Aid And Civil Protection (DG ECHO) of the European Commission aiming at developing and implementing an integrated model for rapid multi-hazard health risk assessment applicable to chemical release incidents occurring during major natural or man-made disasters.
Under this perspective the main problem targeted by PEC is the assessment of the impact on human health due to exposure to chemical agents originating

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either from natural or manmade disasters, such as earthquake, flood or terroristic attack affecting chemical plant structures and infrastructures finally leading to accidental release of large amounts of toxic chemicals into the environment.
The PEC method and tools will be applied on a case study area located in the South-Eastern part of Sicily (Italy). The area was selected considering that it is close to the most active seismic faults in Italy, could be prone to floods and to anthropogenic hazard. The study area and model disasters has been identified assuming toxic chemical release from two hypothetical industrial plants handling respectively benzene/cadmium and arsenic/acrylonitrile.
Immediate and long-term population health impacts of the toxic chemicals absorbed either individually or in combination will be determined and quantified according to (i) characteristics (type and intensity) of the initial disaster, (ii) degree of vulnerability of buildings and infrastructures, (iii) quantity of chemicals stored/handled in the plants, magnitude of their dispersion into the environment and levels of chemical contamination in the disaster area.

Main objectives

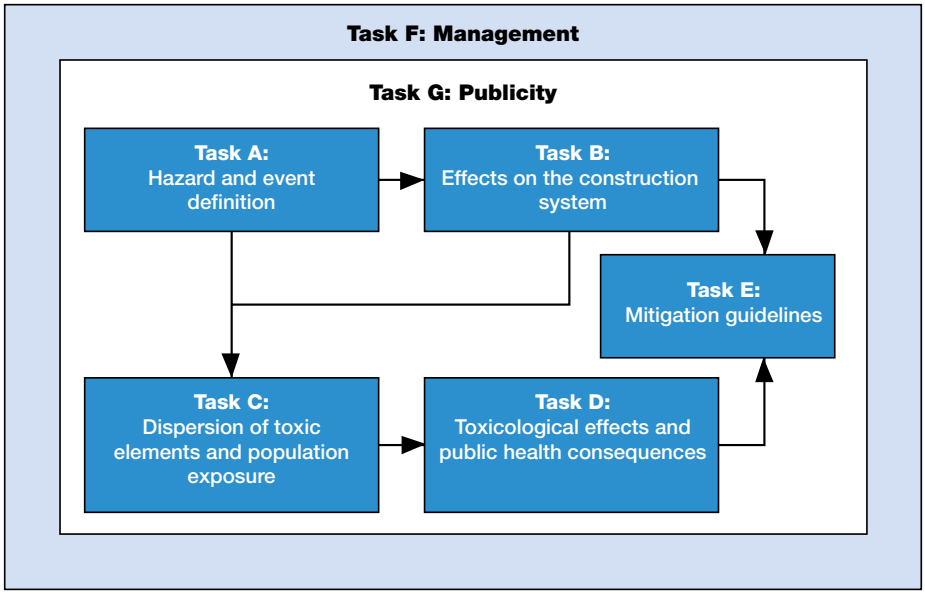
- To develop a methodology for comprehensive and rapid health risk assessment of chemical releases from natural disasters or technological system failure.
- To develop and apply computational tools for risk prioritization in industrial facility clusters and population-based health impact assessment.
- To develop composite risk matrices, considering both severity and probability of identified hazards, to prioritize disaster-related public health risks from clusters of industrial facilities handling toxic chemicals.
- To develop a series of risk mitigation guidelines for characterisation of “multi-hazard and multi- event-related” health risks in chemical exposures following natural or man-made disasters.

Why PEC is necessary

- Current analysis of health impacts associated with accidental release of chemicals from industrial sources is based on knowledge of inherent properties of individual agents and the predictable response to a given dose of the chemical determined by classical health risk assessment methods.
- Limited information exists on health risks posed by absorption of complex chemical mixtures or derived from combined accidents, natural and technological (NaTech) causing environmental release and dispersion of toxic chemicals in the primary disaster area.
- A consolidated methodology for risk assessment of chemical mixtures and combined NaTech hazards is currently not available.

How we work

The PEC project structure was built to stimulate efficient and continuous exchange of information and data between individual actions so as to build a solid process to develop the PEC approach.



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Task A will focus on the event definition and hazard identification. It will provide input to the subsequent analyses, defining the general settings that will be considered as triggering multi-hazard disasters. Task B will assess the effect on the construction system. Analysis of both structural and non-structural elements will be developed to define damage levels due to the natural and/or man-made actions through the development of development of fragility functions of different plant components.
Task C will focus on the study of the dispersion of toxic compounds in the different environmental matrices through the application of multimedia models. From these data exposure profiles will be derived which in turn will feed physiology-based toxicokinetic (PBTK) models to estimate internal doses of chemicals in target tissues.
Exposure data will be used to determine acute health impacts in the affected population and to predict chronic (carcinogenic and non-carcinogenic) effects for both individual chemicals and their combination according to classical health risk assessment procedures (Task D).
From the incident simulations a series of guidelines targeting key stakeholders will be generated (Task E) addressing measures for risk mitigation. Recommendations for the reproducibility and field application of the proposed methodology will be included in the guidelines.
In addition two horizontal tasks will deal with communication outside the project disseminating the project results and raising awareness about the results and resources of the project (Task G). General coordination and management of the project is the aim of Task F.

The study area

The area selected for the PEC case study is located in south-eastern Sicily, the biggest island in southern Italy.
The territory of interest is approximately 330 km^2 and it is subdivided into three main districts:

1. An industrial area (extension about 1 km^2) containing the two chemical plants targeted by simulated natural and/or man-made disasters. The first plants stores and processes benzene and acrylonitrile and the second cadmium and arsenic;
2. An urban densely populated area (extension about 120 km2) surrounding the industrial site;
3. An external semi-rural area (extension 210 km2) in which land is mostly used for agricultural purposes.

The sample population living in the study area at the time of disaster is assumed to be about 200,000 inhabitants, with a total of 155,650 and 52,617 people living, respectively, in the urban area surrounding the industrial district and in the more external semi-rural area.
The initiating event (earthquake, floods, terrorist attack) strikes buildings and infrastructures in the targeted industrial plants with consequent dispersion of considerable amounts of four representative toxic agents, namely acrylonitrile, benzene, arsenic and cadmium firstly in enclosed or semi-enclosed spaces within the industrial plants and subsequently in the open space (ambient air, soil and water) in the territory surrounding the chemical district.

Focus on PEC partners

Eucentre, European Centre for Training and Research in Earthquake Engineering, was founded in 2003 by the following institutions: Italian National Department of Civil Protection, University of Pavia (Italy), Italian Institute of Geophysics and Volcanology (INGV) and Institute of Advanced Study (IUSS) of Pavia (Italy). It is a non-profit foundation with head office in Pavia. EUCENTRE promotes, supports and sustains training and research in the field of seismic risk mitigation.

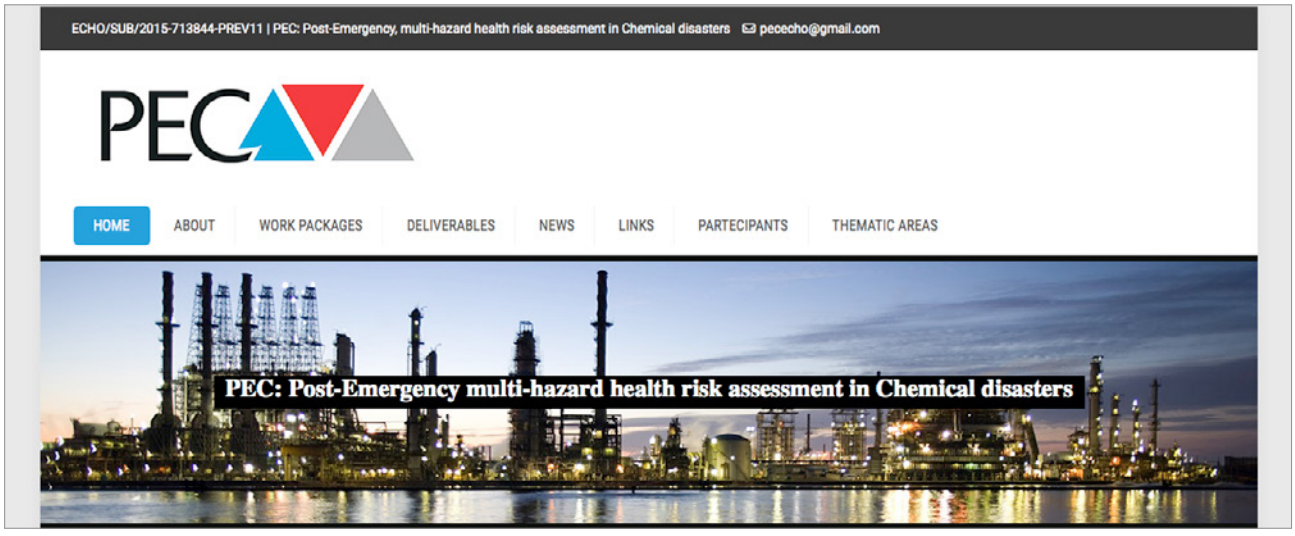
The Environmental Engineering laboratory (EnvE-Lab) of the Chemical Engineering department at the Aristotle University of Thessaloniki (AUTH) was established in 2011, bringing along novel approaches to environment and public health risk assessment and management developed over more than 20 years of international scientific work, including at the University of California at Berkeley and the European Commission's Joint Research Centre. The research work of the Lab focuses on: 1) Environment and Health – development of integrated systems for the assessment of environmental pollution to public health; 2) Advanced Technologies of environmental pollution monitoring and pollution management; and 3) Industrial Ecology – design of industrial systems aiming to reduce ecological footprint.

Delft University of Technology Safety and Security Science Group is a section of the Faculty of Technology, Policy, and Management at Delft University of Technology, The Netherlands. The group is involved in conducting research and developing innovative methodologies in safety and security in a variety of domains including but not limited to chemical plants, civil infrastructures, transportation, human behavior, occupational health and safety, societal safety, and cyber security.

D'Appolonia S.p.A. D'Appolonia S.p.A., part of the RINA Group, is the largest fully independent Italian firm providing consulting & engineering services to Clients belonging both to the public and the private sector. The company operates in the markets of Energy, Transport and Infrastructures, Industry and Investor Support. With a staff of more than 1000 engineers, scientists and associated professionals located in 20 offices worldwide, D'Appolonia offers high-end services to investors, promoters, operators and contractors, insurers and public administrations, taking into due consideration sustainability and health, safety and environmental targets.

PEC website is online

The project website is online, visit **www.pec-echo.eu**



On the website you can find information about the structure of the project, methods, workplan and links to the partners. There is also a section with products such as deliverables, published papers and presentations and an area where and announcements of key scientific events (e.g. workshops, conferences) are reported. The web site is continuously updated with the latest news and deliverables. If you have any documents you would like to have available or would like to add on the PEC website, please let us know.

The PEC leaflet

Main Objectives & Expected Results

- Operational demonstration of an integrated model for rapid **multi-hazard risk assessment applicable to chemical release incidents** occurring during major natural or man-made disasters.
- **Immediate and long-term health impacts** of toxic chemicals taken up by the affected population either individually or in combination will be determined and quantified. A **composite risk matrix** will be constructed to **prioritize** disaster-related public health risks from clusters of industrial facilities handling toxic chemicals.
- An **integrated computational platform** covering the full chain from chemical release to internal dose in human tissue and risk characterization will be developed for use by local authorities responsible for civil safety and public health protection.
- A series of risk **mitigation guidelines** for "multi-hazard and multiple-event-related" health risks from chemical exposure following natural or man-made disasters.
- **Significant improvement of the decision-making processes on environment and health issues** related to accidental release of chemicals from industrial sources.

www.pec-echo.eu

Eucentre Foundation

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Aristotle University of Thessaloniki

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Delft University of Technology

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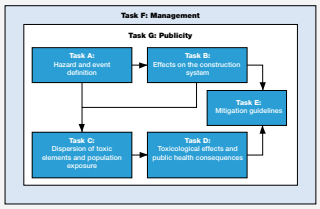
Implementation

The PEC workflow consists of the following tasks:

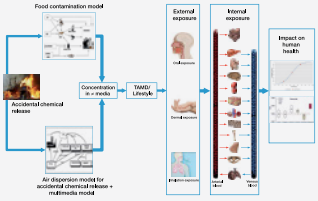
- Task A: Hazard and initiating event definition.
- Task B: Effects on the construction system.
- Task C: Dispersion of toxic elements and population exposure.
- Task D: Toxicological effects and consequences on public health.
- Task E: Guidelines for mitigation of adverse consequences.
- Task G: Project Management.
- Task F: Dissemination and communication of results.



For each type of hazard considered in the project, its determinants will be identified and estimated using statistical and physics-based models (for natural events) and expert judgement including historical databases (for man-made events). Risk evaluation of natural or man-made disasters will be carried out by techniques of quantitative risk analysis coupling the probability of occurrence for both initiative and intermediate events along the risk chain with quantitative estimates of consequences.
Environmental contamination from toxic elements and population exposure will be modelled through state-of-the-art atmospheric dispersion models coupled with an enhanced multimedia model used for regulatory monitoring and compliance purposes to derive concentration levels of toxicants in different environmental media (i.e. surface and groundwater, soil and air) and the food web. Exposure will be assessed by estimating the total daily intake of toxicants based on their predicted environmental concentrations.
Internal exposure will be derived using in silico methods (PBTK, exposome-oriented approaches) resulting in the quantitative estimation of toxicants in human tissue.
Likelihood and severity of predicted effects will be estimated in terms of number of persons affected, short term mortality, overall morbidity, prevalence of local irritation symptoms, and organ/system morbidity requiring hospitalisation. Results obtained from the simulated incident will be validated against clinical data obtained from published case reports and practical experience in medical toxicology and emergency medicine.

PEC Approach

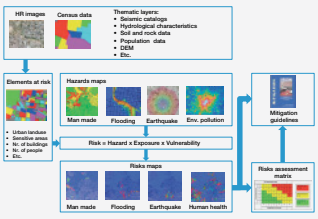
Validated tools (www.epa.gov/riskassessment/guidance.htm) will be used to determine cancer and non-cancer risk for both individual chemicals and their combination according to calculated exposure data and risk zone maps. Estimated cancer risk in the affected population will be expressed as increased cancer incidence over the background. Non-cancer risk will be estimated based on established threshold limit values and reference doses.



Based on the lessons learned from analysis of various incidents guidelines based on cost/benefit analysis will be generated addressing:

- Measures for risk mitigation of structures (i.e. buildings and plants).
- Mitigation of population exposure to the incident-related chemicals and
- Mitigation/prevention of health risks.

Recommendations for the reproducibility and field application of the proposed methodology will be included in the guidelines.



Added Value

The project aims at enhancing knowledge-based disaster prevention policies at European level, integrating actors and policies throughout the disaster management cycle, and improving the performance of existing prevention instruments in key policy areas where the EU is taking actions (see Decision No 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism and its implementing rules (EC(2014)7489 final).

To meet these objectives a transnational multidisciplinary partnership has been put together to (a) address multi-hazard risk assessment for natural or anthropogenic incidents with potentially disruptive consequences, and (b) provide science-based analyses and advice for risk reduction, and improved response procedures and higher level of protection against disasters in Europe.

The PEC methodology does not depend on the geographical location of the application area. Indeed, the project approach could be implemented at any area and / or European country without restructuring the main kernel of the methodological paradigm. Potential beneficiaries and end-users of the results obtained in the project would include cities and communities, public authorities and control agencies responsible for disaster prevention and risk management with special emphasis to organizations involved in the assessment of medium and long-term health consequences of major multi-hazard incidents.

The Civil Protection personnel will also benefit from the ready-to-use software developed during the project. Other potential end-users would be the European Poison Information Centres, Chemical Emergency Centres established by chemical manufacturer associations, health professionals, organisations involved in studies of natural or man-made disasters, and organisations responsible for preparing evaluated data on chemicals, health and safety guidelines, chemical safety measures, and environmental criteria documents.

Next Issue

The next issue will feature other news and documents developed by the PEC Consortium covering the period from July 1, 2016 - to December 31, 2016.

Contact us

For more info: **www.pec-echo.eu**

PEC is a project funded by the European Community's under grant agreement ECHO/SUB/2015-713844-PREV11. The EU does not take over any responsibility for the contents of this newsletter, that reflect only the partner authors views.

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