



Post-Emergency, Multi-Hazard Health Risk Assessment in Chemical Disasters PEC

Deliverable D.G.7

Exploitation study





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1. INTRODUCTION AND MAIN OBJECTIVES OF THE EXPLOITATION PLAN

This Exploitation Plan deliverable describes the expressed intentions of the PEC project consortium members for exploiting the project results. The exploitation activities will take place both during, and following the completion of the project. Partners have reported their strategy and concrete activities to disseminate and exploit the project results.

The purpose of the exploitation Plan is to ensure the use and dissemination of the knowledge generated within the project. It is mainly aimed to the European Commission, in order to communicate the consortium's strategy for exploiting the project results and to the consortium partners as internal notification of the exploitation activities and intentions to further develop the project results in the future.

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2. DESCRIPTION OF PEC PRODUCTS AND SERVICES

The PEC main product is an integrated platform for multi-hazard risk assessment supported by a GIS system which covers the full chain from chemical releases from industrial plants following combined natural and technological (NaTech) accidents down to health impact on the population and workers so as to build a functional and ready-to-use software operated by local authorities responsible for civil safety and public health protection.

Such platform represents the natural enhancement of the existing platform already developed for the Italian Civil Protection System (Sistema Informativo per la Gestione dell'Emergenza-SIGE) for several type of structures and infrastructures by completing it with the assessment of the industrial plants damage scenario. The platform will allow to define and launch simulations for risk assessments and damage scenarios analysis to produce results consistent with those obtained by SIGE.

In this perspective the platform constitutes a graphical interface for structure and infrastructure exposure and vulnerability data, allow to visualize risk maps with an effect graphics and allow to calculate in real time the scenarios of damage in the hypothesis of NaTech disasters.

In this perspective the most important added value of the PEC platform is the estimation of the impact on the environment and on the human health following NaTech accidents through the application of a methodological framework which encompasses the following steps: i) estimation of the environmental contamination in different matrices (air, soil, water, food) through the application of multimedia and dietary contamination state-of-the-art models; ii) estimation of aggregated and cumulative human exposure to toxic chemicals through the application of advanced multi-route exposure models addressing the main exposure routes, namely inhalation, skin contact and ingestion; iii) assessment of internal dose of toxic compounds and their metabolites in human tissues through the application of state-of-the-art Physiology-Based Toxicokinetic (PBTk) models parameterized for a wide chemical space and iv) estimation of the health impact on the general



population and workers both for short term (acute) and long-term (chronic) exposure. Acute toxicity is evaluated in accordance with empirical principles of evidence-based emergency medicine and human toxicology, based on recognition of general clinical syndromes. Likelihood and severity of predicted effects are estimated in terms of number of persons affected, short-term mortality, overall morbidity, prevalence of local irritation symptoms, and organ/system morbidities requiring hospitalisation. Chronic toxicity is evaluated through validated tools¹ to determine both carcinogenic and non-carcinogenic risks for both individual chemicals and their combination according to exposure data. Estimated cancer risk in the affected population is expressed as increased incidence of cancer over the background. Non-cancer risk is calculated based on established threshold limits and reference doses.

The platform is compatible with the indications issued by Italian Civil Protection Department "Standards for data and metadata formats", "Specifications for the delivery of software applications" and "Guidelines for the identification and processing of data for the purpose of their publication (transparency) and reuse (open data) " and as such fully and readily exploitable toward the Italian Civil Protection system.

A further class of products released by PEC is represented by the Guidelines issued by the project. The latter provide a series of concrete and ready-to-use risk mitigation guidelines for characterization of “multi-hazard and multi-event-related” health risks in chemical exposures following natural or man-made disasters tackling the multiple aspects of prevention, preparedness and response namely early warning systems; risk mitigation of buildings and plants; population exposure mitigation; environmental and human health monitoring and; design of post-disaster populations surveys.

The PEC platform together with the Guidelines represent a bundle of tools and methods all inside the chain of NaTech disasters monitoring and management.

The totality of selected PEC products and services has been classified into in 4 categories: Final products, intermediate products, PEC systems and PEC services.

Final Products

- Environmental contamination maps
- Human exposure profiles
- Pollution and risk mitigation information for the citizens
- Health impacts assessment information (disaggregated by gender and age class)
- Web integrated risk communication (Web-GIS)
- PEC Guidelines

Intermediate products

¹ www.epa.gov/riskassessment/guidance.htm



- Susceptibility of the structures included in plants
- Vulnerability of components subjected to the effects of industrial accidents
- Fragility functions of different plant components
- Damage levels on structural and non-structural components due seismic, flooding and man-made disasters
- Multi-hazard contamination risk map

The above products will be marketed at different scales, for any requested area.

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PEC Systems

- PEC Integrated Platform

The PEC Integrated Platform will be offered, upon user request, at different complexity levels.

PEC Services

- Provision of various combinations of PEC products
- System operation and management (outsourcing) for third parties (different combinations of PEC system modules)

User driven PEC based services will be available to the European market, after the end of the project, to cover a wide range of natural and man-made disasters monitoring needs at local and regional level.

Additional services (maintenance, help-desk, assistance, etc.)

In the case of selling of the PEC platform, the following additional services should be guaranteed:

- Technical assistance
- Hardware / Software Maintenance
- Help desk for rapid response to technical problems
- Software upgrading

3. IDENTIFICATION OF STAKEHOLDERS AND POTENTIAL USERS

In its final version, PEC will serve several communication and management purposes as an example: In the **short run** showing overall trends (i.e. distance to threshold values), its early warning function will ensure that:

- Urban and regional administrations get more reliable information when having to decide on emergency measures in case of NaTech incidents; in this context, PEC will support the issuing of health advisories and it will drive exposure reduction strategies based on early warning of chemical incidents.



- Citizens and stakeholders affected by such measures can reliably anticipate such measures (e.g. through trend extrapolations published via newspapers, local radios etc.), and plan appropriate reactions.

In the **long run**, monitoring and assessing chronic exposure of pollution-related problem will ensure that:

- Urban and regional administrations responsible for environment and health protection are enabled to take decisions on the design of infrastructure based on transparent evaluations alternative solutions.
- National and EU administrations will get more convincing information on the effects of interregional and national policy decisions.

Identified target groups ensure the use and dissemination of the knowledge generated. Exploitation demonstrates the added value of the project and the results. It also maximizes the impact of the funding granted in the market. The PEC exploitation activities are mainly addressed towards the following end-users groups.

3.1 Central government and agencies

Main users are national agencies and administrations. These organizations are involved as users for non-commercial, nationally funded applications. In this context, use of NaTech disasters monitoring and management applications will be devolved to managing agencies that required detailed functional specifications.

Potential Interested Organizations include:

- Civil Protection Agencies
- Ministries of Environment (Environmental Protection Programmes)
- National Centers for Public Health
- National Institutes of Environmental Health
- Ministries of Culture
- The National Air Quality Topic Centers of the European Environmental Agency-EEA

3.2 Local administrations

Main users are regional institutions and local administrations. These organizations are involved as users for non-commercial, locally funded applications.

Potential Interested Authorities include:

- Regional Administrations for Environmental Protection and Public Health
- Regional Environmental Protection Agencies
- Regional Environmental non-profit Organizations



- Municipalities
- Cities Agencies and Organizations

3.3 International Organizations

These organizations operate within the application on a national and international basis. From a funding viewpoint, they operate in a similar way to central government, requiring both application detail and broader cost benefit analyses to justify investment and spend.

Potential Interested Authorities include:

- European Commission (DG ECHO, DG ENV, DG SANTE, DG REGIO)
- Organisation for Economic Co-operation and Development
- United Nations
- European Environmental Agency
- World Health Organization - Chemical Risk Network
- European Poison Information Centres

3.4 Chemical Industry

PEC software and guidelines for methods of intervention for risk mitigation will potentially become a further asset for chemical plant operators and safety engineering consultants as well as public authorities in order to make for a mutually accepted tool for post-disaster risk assessment and management. Industry associations such as CEFIC, Federchimica and Chemical Emergency Centres established by chemical manufacturer associations are considered key stakeholders in this area.

4. LEGAL FRAMEWORK FOR CHEMICAL ACCIDENTS MANAGEMENT AND MONITORING

The well-defined legal framework in the form of policies, guidelines, rules, regulations and recommendation, is an effective tool to reduce/mitigate the public health risk posed by chemical accidents. Legal framework regulates the chemical accident risk by controlling the risk of leak, spill, explosion, fire, vapours etc., at every level, such as production, transportation, usability, disposal etc. Seveso III, OECD guidelines, UN (UNEP) along with international organizations: United Nations Industrial Development Organization, International Labour Organization, World Health Organization, United Nations Economic Commission for Europe (UNECE), World Health Organisation, United Nations Institute for Training and Research, Joint United Nations Environment Programme (UNEP), Coordination of Humanitarian Affairs Environment Unit (JEU), European Commission's Joint Research Centre, International Council of Chemical Associations, and Asian Disaster Preparedness Center), are some of the organizations who have developed the legal framework for chemical accident management and monitoring. The general principle of the legal framework are;



- To save lives, and protect health and the environment from chemical accidents.
- To reduce economic impacts such as property damage, loss of employment, bankruptcy, costs related to response, clean-up and recovery, and/or costs incurred by other surrounding industries in the vicinity of an accident.
- For compliance to international agreements, or recommendations, related to reducing chemical risks. At the national level, it helps improve cooperation and coordination among the many agencies and bodies with relevant responsibilities. At the local level, it provides a platform for improving communication and trust between local leaders, the public, and other stakeholders.

Sendai Framework for Disaster Risk Reduction

The Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted at the Third UN World Conference in Sendai, Japan, on March 18, 2015. This framework is binding to the UN Members. The Sendai Framework articulates: the need for improved understanding of disaster risk in all its dimensions of exposure, vulnerability and hazard characteristics; the strengthening of disaster risk governance, including national platforms; accountability for disaster risk management; preparedness to “Build Back Better”; recognition of stakeholders and their roles; mobilization of risk-sensitive investment to avoid the creation of new risk; resilience of health infrastructure, cultural heritage and work-places; strengthening of international cooperation and global partnership, including financial support and loans from international financial institutions.

Sendai framework has identified the 4 priority areas namely: Understanding disaster risk, strengthening disaster risk governance to manage disaster risk, investing in disaster risk reduction and Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery. Besides this framework describes the targets to be achieved with the help of 13 guiding principles².

Seveso Directive III

The Seveso-III-Directive (2012/18/EU) aims at the prevention of major accidents involving dangerous substances. However, as accidents may nevertheless occur, it also aims at limiting the consequences of such accidents not only for human health but also for the environment.

The Directive establishes a framework for the prevention of major accidents which involve dangerous substances, and the limitation of their consequences for human health and the environment through risk assessment, prevention and management actions. Rules apply to establishments and competent authorities and focus on risk assessment, safety management, land-use planning, information, inspections, and mitigation actions.

The Directive covers industrial plants where dangerous substances may be present (e.g. during processing or storage) in quantities exceeding certain threshold. Excluded from the Directive are

² http://www.ifrc.org/docs/IDRL/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf



certain industrial activities which are subject to other legislation providing a similar level of protection (e.g. nuclear establishments or the transport of dangerous substances). Depending on the amount of dangerous substances present, establishments are categorised in lower and upper tier, the latter are subject to more stringent requirements.

Seveso directive III controls the chemical accident risk through: a) performance monitoring - Active monitoring should include inspections of safety critical plant, equipment and instrumentation as well as assessment of compliance with training, instructions and safe working practices, b) audit and review - a review is a more fundamental study of whether the Safety Management System is appropriate to fulfil the operator's policy and objectives, and may extend to considering whether the policy and objectives should themselves be modified, c) prevention - The operator is obliged to take all measures necessary to prevent major accidents and to limit their consequences for man and the environment, d) preparedness - implementing the measures necessary to protect man and the environment from the effects of major accidents and e) response - emergency plans are put into effect without delay by the operator and, if necessary by the competent authority designated for a major accident occurs, or when an uncontrolled event occurs which by its nature could reasonably be expected to lead to a major accident.

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Registration, Evaluation, Authorization and Restrictions of chemicals (REACH).

REACH Regulation (EC 1907/2006) aims to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances. This is done by the four processes of REACH, namely the registration, evaluation, authorisation and restriction of chemicals. REACH also aims to enhance innovation and competitiveness of the EU chemicals industry.

"No data no market": the REACH Regulation places responsibility on industry to manage the risks from chemicals and to provide safety information on the substances. Manufacturers and importers are required to gather information on the properties of their chemical substances, which will allow their safe handling, and to register the information in a central database in the European Chemicals Agency (ECHA). The Agency is the central point in the REACH system: it manages the databases necessary to operate the system, co-ordinates the in-depth evaluation of suspicious chemicals and is building up a public database in which consumers and professionals can find hazard information.

One of the main reasons for developing and adopting the REACH Regulation was that a large number of substances have been manufactured and placed on the market in Europe for many years, sometimes in very high amounts, and yet there is insufficient information on the hazards that they pose to human health and the environment. There is a need to fill these information gaps to ensure that industry is able to assess hazards and risks of the substances, and to identify and implement the risk management measures to protect humans and the environment.

Under REACH (Art 126) the Member States authorities are responsible for the enforcement of the REACH provisions. In other words, each Member State must determine inter alia the penalties that



would apply to the infringement of REACH provisions and must take all measures necessary to ensure that they are implemented. The penalties must be "effective, proportionate and dissuasive". The Member States had to notify their provisions to the European Commission and must also notify any subsequent amendment. Linked below is the report on the Member State penalties, prepared for the Commission by a contractor.

Flexible Framework for Addressing Chemical Accident Prevention and Preparedness (Guidance)

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In 2010, UNEP together with collaborating organisations and experts developed a Flexible Framework for Addressing Chemical Accident Prevention and Preparedness – A Guidance Document (Flexible Framework Guidance) to assist governments in developing, reviewing, or revising a chemical accident prevention and preparedness (CAPP) programme. It provides in-depth information on steps that are needed before developing and implementing an effective CAPP, sets out possible elements of such programme, and provides resource materials related to how these elements may be implemented. By applying the approach suggested in the *Flexible Framework Guidance*, a country can focus on those elements that are relevant to its legal and cultural context and can define actions based on the nature and extent of national priorities, resources and experiences.

The *Flexible Framework Guidance* was designed to be used globally in a variety of contexts based on countries' needs, resources and capabilities. It is intended to be a valuable tool for a wide range of countries, including those with few or no activities or systems in place to address chemical accident prevention and preparedness, as well as those that have some competencies in this area and want to determine whether improvements can be made.

The Flexible Framework aims to:

- Increase countries' understanding of issues related to chemical accident prevention and preparedness
- Improve the capacity of relevant institutions, agencies and experts to address the risks of chemical accidents
- Help countries to develop and implement an appropriate CAPP programme. These programmes encompass the collection of laws, regulations, policies, guidance, and other instruments developed by a country to address the various aspects of CAPP.

The Guidance focuses on prevention and preparedness for industrial accidents at "hazardous installations" which include places where hazardous substances are produced, processed, used, handled or stored in such quantities and under such conditions that a chemical accident could occur. The types of accidents addressed by the Guidance would include any loss of containment, explosion, or fire involving chemicals which pose a risk to human health or the environment.

OECD



OECD has developed their own guidelines and recommendations about prevention, emergency preparedness and response, role of stakeholders etc. in great detail. The detail information of the actual recommendations and guidelines are explained in the Task D.E.3 of PEC Project.

Other important EU policies contributing to Disaster Risk Management are summarized below.

Decision 1313/2013 on a Union Civil Protection Mechanism: strengthens the cooperation between the Union and the Member States and facilitates coordination in the field of civil protection in order to improve the effectiveness of systems for preventing, preparing for and responding to natural and man-made disasters, including through risk assessments, improved risk management planning, peer reviews and assessment of risk management capabilities.

COM(2009) 82 Communication on a 'Community approach to the prevention of natural and man-made disasters': aims at (1) improving the knowledge base on disasters, their impacts and their prevention, (2) linking the diversity of players that should be involved in disaster prevention, (3) spreading and stimulating the uptake of good practice, (4) making existing financial and legislative instruments perform better for disaster prevention.

COM (2013) 216 An EU strategy on adaptation to climate change (together with accompanying documents, including Staff Working Documents and the Green Paper on insurance of natural and man-made disasters): aims to contribute to a more climate-resilient Europe through adaptation actions at national, regional and local level developed in synergy and full coordination with disaster risk management policies

Directive 2007/60/EC on the assessment and management of flood risks ('Floods Directive'): aims to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity through specific actions undertaken by Member States, including flood risk assessment and risk management plans

Directive 2000/60/EC establishing a framework for Community action in the field of water policy ('Water Framework Directive'): establishes a framework for the protection of waters through integrated river basin management plans, addressing also water scarcity and drought

COM (2012)0673 A Blueprint to Safeguard Europe's Water Resources: sets out actions by 2020 to better implement existing water legislation, integrate water policy objectives into other policies, and fill the gaps in particular as regards water quantity and efficiency.

COM (2013)0249 Communication on Green infrastructure: strengthens the contribution of green infrastructure to the effective implementation of all policies through nature-based solutions, including for disaster risk management policy and building disaster resilience.

Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community (INSPIRE): improves the provision of information and good quality data across EU Member States.



Decision No 1082/2013/EU on serious cross-border threats to health and repealing Decision No 2119/98/EC: contributes to a high level of public health protection in the Union through epidemiological surveillance, monitoring, early warning of, and combating serious cross-border threats to health, including preparedness and response planning related to those activities, in order to coordinate and complement national policies

SWD(2013) 318 New approach to the European Programme for Critical Infrastructure Protection Making European Critical Infrastructures more secure: sets new approach to ensure a high degree of protection of EU critical infrastructures and increase their resilience against all threats and hazards.

Regulation (EU) No 911/2010 establishing the European earth monitoring programme (GMES) and the rules for the implementation of its initial operations: provides an emergency management service of information for emergency response in relation to different types of disasters, including meteorological hazards, geophysical hazards, deliberate and accidental man-made disasters and other humanitarian disasters, as well as the prevention, preparedness, response and recovery activities.

COM(2014)14 For a European Industrial Renaissance and SWD (2014)14/3 State of the Industry, Sectoral overview, and Implementation of EU Industrial Policy: sets out the Commission key priorities for industrial policy and presents the current state of European manufacturing industry, recognising also the need for increased investment into infrastructure resilient to disasters.

DIPECHO (Disaster Preparedness programme ECHO): aims to have better prepared communities and local institutions to face disasters caused by natural phenomena; to promote replication of successful community disaster preparedness achievements to advocate for long term involvement in disaster risk reduction by development donors/authorities

4.1 PEC Countries

The key institutional bodies responsible for monitoring, coordinating and managing NaTech accidents are reported with regard to the countries where the PEC project was implemented

Italy

The chemical accident is primarily managed by Italian Civil Protection. It is complex system made of several organizations run by the state and the territorial authorities, as well as by the private sector ([IFRC 2014](#)). This is a peculiar feature of Italian disaster response, which differentiates it from other systems, where this activity is managed in a centralized manner.

The Italian Civil Protection establishment was formalized under Law 966/70, which together with DPR 66/1981 and DL 57/1982 redefined the civil protection design, giving it three main features: first, civil protection activities had to be managed centrally by the state; second, control over civil protection activities was shared among the President of the Council, the Minister of Home Affairs, and the Minister of Civil Protection, making for an unclear control scheme; and third, there was no



systematic coordination between public and private initiatives. That scheme was significantly changed by L 225/1992, which transformed civil protection into a network of organizations, a characteristic maintained by the current system. Under the 1992 reform, civil protection has become a service (servizio della Protezione Civile) and is delivered by organizations and institutions, both national and local, both public and private. The system was further de-centralized under DLgs 112/1998 and the constitutional reform of 2001.

The Red Cross play such a pivotal role in civil protection that its representatives are involved in the operational civil protection committee, which is composed of the representatives of civil protection components and coordinates emergency activities. Given how important territorial authorities are for civil protection, it would be logical for the Red Cross to also be involved in operational coordination at the regional level. It would seem, however, that regional laws rarely ensure the full participation of the Red Cross in organs that provide operational coordination at the regional level.

Under Art. 118 of the Italian Constitution, the state, the regions, the metropolitan cities, the provinces, and the municipalities are required to promote the spontaneous initiatives of citizens, individually or in groups, aimed at providing activities in the public interest. In other words, the action of public authorities should be complementary to that of private entities. This principle is generally referred to as horizontal subsidiarity.

This form of subsidiarity characterises the service of civil protection in an evident manner. Under Law 225/1992, the civil protection initiatives may be performed by ‘any institution or organization, including private ones.’ These entities can enter into arrangements with public authorities in order to regulate their participation in the Civil Protection Service. A particular class of private organizations contributing to civil protection is that of public utility companies, which includes companies managing the highways, the railways, the tele- phone lines, television, the postal service, and electric energy.

Greece

The government’s institutional focus for chemicals management is the General Chemical State Laboratory (GCSL - www.gcsl.gr) under the Hellenic Ministry of Finance. The GCSL maintains a National Register of Chemical Products and serves as the national focal point for several chemical issues. GCSL is a General Directorate, whose mission comprises:

- Provision of scientific and technical support to the Customs, Tax and Revenue authorities and other services of the Ministry of Finance and Economy.
- Support the State’s financial interests.
- Protection of public health and the environment.
- Protection of health and interests of consumers.
- Provision of scientific support to judicial, police and other state authorities.



- Support of the proper function of the market.

A number of Guidelines have been published to ensure a more efficient implementation of the Directive in EU Member States. In Greece, the Seveso II Directive is implemented through JMD 12044/613/19.3.2007 (OJG376/B/19.3.2007), as amended in OJG2259/B/27. 11. 2007 ([UN 2004](#)). The competent authority for the Seveso II Directive is YPEKA. Further information is provided in the site of YPEKA (<http://www.ypeka.gr/Default.aspx?tabid=548&language=el-GR>).

Greece ratified the 1992 UNECE Convention on the Trans-boundary Effects of Industrial Accidents (entered into force on 19 April 2000) in 1997 (Law 2546/1997, OJG 256/? /16.12.1997).

Netherlands

The overall responsibility for safety in the Netherlands rests with the Ministry of Security and Justice (former Justice Department, with additional tasks and authority) ([Sanneke Kuipers, 2013](#)). The Ministry is comprised of five directorates: Threats (risk management and reduction), Resilience (response and relief), Interests (protection of critical infrastructures), Cybersecurity and Strategy & Management.

In the Netherlands, crisis responsibilities are legally institutionalized and the following acts provide the administrative and operational framework for the physical aspects of civil protection.

The Safety Region's Act (2010) replaces the Disaster and Heavy Accidents Act, the Act on Medical Assistance in Times of Disaster and the Fire Service Act of 1985. Since the 1980s, there is no 'formal disaster declaration' equivalent to that in other countries. Municipal and regional decision makers have to assess in each given situation whether extraordinary authority, according to the mandates in the Safety Region Act and other laws, is necessary for drastic intervention or response (and whether this drastic intervention is necessary in the first place).

The Safety Region's Act includes quality requirements for fire and rescue services, emergency medical services and training and preparation efforts within the safety regions. In the preparation phase, the CdK can give instructions to safety regions when the Inspection for Public Order and Safety (IOOV) indicates a lack of preparedness, based on IOOV assessment.

Medical assistance in times of disaster is an integral part of disaster management and is designed to provide the best possible treatment to as many victims as possible. In the event of major incidents and disasters, the director of the regional public health service is in charge of the organisation, coordination and management of medical assistance.

In extraordinary circumstances a variety of other emergency laws can also be applied, such as the Coordination of Exceptional Situations Act, the Extraordinary Competences of Civil Authority Act, the Evacuation Act and the War Act. These acts will be applied by royal decree at the request of the prime minister. According to Art. 103 of the Constitution, deviation from constitutional regulations and certain human rights is possible during an emergency.



5. EXPLOITATION STRATEGY

5.1 Exploitation process phases

The overall exploitation framework can be divided into three phases, the “Start-up Phase”, the “Trial Phase” and the “Expansion Phase”. These phases represent major steps towards the establishment of an economically viable product placement. To a certain degree, these phases can also be used as success indicators or milestones in the overall exploitation process chain.

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Figure 1: Project and Marketing phases

a) Start-up Phase

The Start-up Phase covered the initial phase of the project when direct contact with the future stakeholders needed to be established. It can also be seen as an orientation phase because it is not clear at this stage if the services and products will be appropriate or available at the end of the project. The Start-up Phase ends when the first set of contents has been prepared.

In particular, the following general actions were put into practice during the Start-up Phase:

- Detailed / final definition of the target groups
- Listing of potential stakeholders (organisations) in the countries and regions
- Grouping of the organisations according to identified demands
- Preparation of basic information material
- Establishing of first contacts to the future stakeholders
- Development of a PEC corporate design and brand

b) Trial and Evaluation Phase

Next phase is the Trial and Evaluation Phase. This phase will continue also after the project ends since the process evaluation and optimization of the project products and services is a crucial process for their future success. The optimization will partly be carried out during the project implementation phase and will aim to reach a critical number of stakeholders. To reach as many stakeholders as possible broad marketing measures are needed.

For example, it is necessary to:

- Prepare and disseminate product-specific information material

- Contact stakeholders, particularly thematic networks, associations, lobby groups and multiplier organisations
- Present the PEC product at conferences and workshops
- Evaluate and optimise the product in cooperation with future stakeholders groups

c) Expansion Phase

The Expansion Phase covers the post-project period only. The main purpose of this phase is: a) the consolidation, and b) the expansion of the stakeholders base and the introduction of the product to new markets. These new markets may be outside the current reach and scope of the project partners and therefore the Expansion Phase is not necessarily limited and may possibly run for several years.

In particular, the following actions need to be put into practice:

- Realisation of long-term marketing measures
- Extension of the stakeholders/client base
- Extension of the geographical scope of product availability
- Lobbying EU, national, regional and local institutions

5.2 Exploitation processes

Based on the above stated dissemination and marketing aspects an overall exploitation strategy for the PEC product is needed. The following tables indicate which of the instruments are suitable according to time (long and short-term), target groups and market phases. The short-term phase comprises mainly the project duration whereas long-term means the following exploitation period.

Table 1: Long- and short term exploitation instruments

	Short-term	Long-term
Traditional dissemination and marketing instruments		
Flyer	X (Project flyer)	X (Product flyer)
Power Point presentation (PPT)	X (Project PPT)	X (Product PPT)
Poster	X	X
Newsletter	X	
Press release / Media communication	X	
Online dissemination and marketing instruments		

Websites (Product, project or partner websites)	X (Project website)	X (Project / Partner websites/ Product website)
Direct dissemination and marketing instruments		
E-mailings		X
Conferences		
Workshops	X	X
Conferences and fairs	X	X
Individual marketing		
Individual marketing events (at the stakeholders' venue)		X

Table 2: Marketing Instruments and marketing phases

	Start-up Phase	Trial Phase	Expansion Phase
Traditional dissemination and marketing instruments			
Flyer	X (Project flyer)	X (Product flyer)	X (Product flyer)
Power Point presentation (PPT)	X (Project PPT)	X (Product PPT)	X (Product PPT)
Poster	X	X	X
Newsletter	X	X	
Press release / Media communication	X	X	X
Online dissemination and marketing instruments			
Websites (Product, project or partner websites)	X (Project website)	X(Project/ Partner website)	X (Project / Product website)
Direct dissemination and marketing instruments			
E-mailings		X	X
Conferences			
Workshops		X	X

Conferences and fairs		X	X
Individual marketing			
Individual marketing events (at the clients' venue)		(X)	X

6. MARKET ANALYSIS

6.1 Geographic market

The main PEC geographic market is European Union Members and Associates namely, Central and Northern Europe, Southern and Eastern Europe. Meanwhile, the PEC partners are interested to expand this market territory by including countries from Mediterranean basin (North Africa and Middle East), North and South America and Asia.

The kind of market PEC will address depends heavily on public/government funds, as it is generally the case for all disaster management service related markets. The addressable market size can vary from year to year, as a function of allocation of funds by the different users (at international, national and local level).

Apart from the government-driven markets, the commercial market could develop quite strongly in the coming years as a function of the international and EU-driven legislation acts (e.g. “polluters pay approach”).

6.2 Reference Market (key users)

Main users are certainly National and International Agencies especially the ones dealing with Civil Protection, besides of Administrations, like or National and European Agencies. These organizations are involved as users for essentially non-commercial, nationally and/or internationally funded applications.

These organizations operate within the application on a national and international basis, and, from a funding viewpoint, they operate in a similar way to central government, requiring both application detail and broader cost benefit analyses to justify investment and spend.

Civil Protection Agencies have the main task (also depending on the specific Country):

- to monitor emergency situations throughout the national territory,
- to coordinate the activities for an effective and efficient response to NaTech disasters,
- to inform local administrations and citizen about NaTech accidents,
- to realize and make use of decision support systems for the local administrations and National governments.



At European level the EU Civil Protection Mechanism was established in 2001, fostering cooperation among national civil protection authorities across Europe. The Mechanism currently includes all 28 EU Member States in addition to Iceland, Montenegro, Norway, Serbia, the former Yugoslav Republic of Macedonia and Turkey. The Mechanism was set up to enable coordinated assistance from the participating states to victims of natural and man-made disasters in Europe and elsewhere.

Further, on 23 November 2017, the European Commission proposed to create a new system for a stronger collective European response to disasters. This foresees the creation of *rescEU*, a reserve of new civil protection capabilities managed by the EU to be used to support the collective response to disasters such as floods, forest fires, earthquakes and epidemics. In parallel, the EU will provide additional incentives for Member States to pool their national capacities by financing the adaptation, repair, transport and operation costs. This reinforcement of capacities will allow the EU to better respond to disasters, especially when several disasters take place simultaneously.

These increased disaster response capacities will be complemented by better prevention and preparedness systems, ensuring stronger national prevention strategies and closer cooperation and links with other EU policies dealing with disaster prevention.

The contribution of PEC key products namely the PEC platform and guidelines can be relevant for both National and International Agencies in particular for providing information and data on the impacts of NaTech accidents on structures, infrastructures, environment and human health and on the ways to manage and mitigate them.

6.3 Private market

Despite the fact that most of commercial organizations are looking at applications in other market segments than the NaTech disaster monitoring and management, some PEC services may potentially impact on the operations of some industries.

Commercial Organisations are not seen as “a primary” target for PEC derived products and services. However, chemical industries could become interested in PEC products especially with regard to the guidelines issued by PEC in terms of risk mitigation of buildings and plants so as to support the design of safer chemical plants for effective multi-hazard risk reduction of new and existing industrial equipment.

6.4 How can PEC fill the existing gaps in chemical accidents management and monitoring

Despite monitoring and management of NaTech accidents in chemical industry is an area for applied research with important environmental and health implications only few efforts were made to integrate assessment of structural and infrastructural damage levels with the subsequent impacts on the environment and on the human health of population living close to the accident areas.



In addition, analysis of the health impacts associated with accidental release of chemicals from industrial sources is currently based on knowledge of inherent properties of individual agents (toxicity, flammability, explosivity, etc.) and the predictable response to a given dose of the chemical determined by classical health risk assessment methods. Very limited information exists on health risks that may result from absorption of complex chemical mixtures or from combined accidents that devastates chemical installations causing environmental release and dispersion of toxic chemicals in the primary disaster area.

PEC bridges this gap through the development and implementation of an integrated methodological paradigm implemented in multi-hazard risk assessment toolkit where all the main components of NaTech disasters (i.e. structural, environmental and health) are addressed in a single integrated state-of-the-art framework which has been tested on a specific case study.

Immediate and long-term population health impacts of the toxic chemicals absorbed either individually or in combination can be determined to provide strategic risk information for public health planning.

6.5 Benefit description

PEC developed and demonstrated on a specific case study the operability of an integrated monitoring and management system for NaTech accidents suitable for applications at the urban, regional and trans-boundary scales.

In this perspective, PEC products and services contribute to enhance knowledge-based disaster prevention policies at European level, integrate the actors and policies throughout the disaster management cycle, and improve 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 (C(2014)7489 final).

PEC has set a strategic objective: to provide a system, which should be able to be adopted and operated not only by the current EU Member States, but also by candidate countries. This strategic objective is quintessential in order to ensure coherent international environmental monitoring and to support the harmonization of best environmental management practices across the EU and in the candidate to accession states.

From the business point of view, this will allow to the industrial partners to operate in a wider Market Territory and expand their business opportunities. In this perspective it has to be underlined that disasters monitoring and management is an international issue involving coordinated environmental action and policies among neighbouring countries in the EU and amongst candidate to accession countries.

The PEC System has been designed to be flexible so that, models improvement and refinement can be seamless integrated assuring long-term business horizons. The PEC System is also flexible in its



networking and communication component in order to be open and in new technological developments, and remain an interested product to the International Disaster Management Market

7. SUSTAINABILITY STRATEGY

7.1 Important activities to continue after the project

The main activities to be continued or maintained after the end of the project are hereinafter reported.

Follow up and monitoring of impact: the outcome of the project will be monitored through the local partners who are well established in the local community as reference centres for public health planning and preparedness. The collaboration that has already been established with local stakeholders, including policy-makers and local authorities responsible for public health management and planning makes sure that impact monitoring will continue after project closure.

Data management and computational system. The integrated computational platform developed during the project will support public health authorities, consultants, industry to interpret different types of data in order to perform risk analysis arising from accidental toxics releases following chemical disasters. As earlier detailed the output of PEC will be readily accessible to users and the computing architecture would provide the computer power to make the PEC computational platform an integrated tool ready-to-use by local authorities responsible for civil safety and public health protection that would live beyond the lifetime of the project. The PEC platform will support the effective communication on chemical disaster risks, enhance stakeholder cooperation promoting chemical safety, and help raise awareness of population and industry. The integrated computational platform will be maintained after the end of the project and if needed refined to reflect scientific progress and be at par with the state of the art.

The dissemination of project results both: (a) to the local and regional communities and industrial and institutional stakeholders (e.g. public administrations competent for environmental planning and health issues); and (b) to interested stakeholders and the public at large at the national and international scales will be continued after the end of the project, through the active participation to ad-hoc workshops and specific conferences in order to ensure that the experience from the project can be duplicated and transferred to other areas in Europe as well.

To this end one of the first actions PEC partners are planning is the organization of a scientific workshop with key stakeholders including the Italian Civil Protection Department after the end of the project (tentatively in March – April 2018).

The results and conclusions coming out from the project collated into **guideline for impacts mitigation** will be distributed among key stakeholders for widespread dissemination and use after the end of the project. Beside through the PEC web site, the guidelines will be widely disseminated through the EU COST program, since AUTH is national representative and member of the

management board to the most relevant COST action on health impacts of contaminated sites (led by the Italian Public Health Institute).

The coordinating beneficiary will maintain the **PEC web portal** and the local end-users will have the responsibility to provide access to updated information after project completion. Academic partner (AUTH) will include the findings of the project in educational curricula for professional training and public awareness tools through their dedicated web site.

First important results in terms of **exploitation towards the academic sector** include the establishment of an ordinary course on environmental health engineering covering most of the topics addressed by the PEC project hosted by The University School for Advanced Studies IUSS Pavia linked to Eucentre.

In addition, the UME (Understanding and Managing Extremes) School, a graduate training institution of the Institute for Advanced Study in Pavia (IUSS), hosted at Eucentre already run Masters and PhD programmes in Risk and Emergency Management (REM), in Earthquake Engineering and Engineering Seismology, in Weather Related-Risk (WRR) and is now planning to activate a Masters in Toxicological Risk to increase awareness and to convince international teaching and student bodies to adopt and apply the products (e.g. methodologies, software etc.) of the project in their future activities.