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LIFE SECURDOMINO

Seveso sites: assessment of integrated safety-security hazards and risks and related domino effects

LAYMAN'S REPORT

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LIFE programme

The financial instrument for the environment or **L'Instrument Financier pour l'Environnement** (LIFE), born in 1992, supports demonstration, best practice, coordination and support actions, capacity building, and governance projects.
This includes large scale Strategic Integrated Projects and Strategic Nature projects, which support the implementation of environmental and climate plans, as well as programmes and strategies developed at regional, multi-regional or national level.
The LIFE programme aims to

- facilitate the shift towards a sustainable, circular, energy-efficient, renewable energy-based, climate-neutral and resilient economy
- protect, restore and improve the quality of the environment, including the air, water and soil
- halt and reverse biodiversity loss
- tackle the degradation of ecosystems.

The financial envelope of the **LIFE Programme 2014-2020** with a budget of €3.4 billion, was divided into two sub-programmes, one for **environment** (representing 75% of the overall financial envelope) and one for **climate action** (representing 25% of the envelope). (source: https://cinea.ec.europa.eu)

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LIFE SECURDOMINO in a nutshell...

Seveso sites: assessment of integrated safety-security hazards and risks and related domino effects

LIFE20 ENV/IT/000436

WEBSITE: www.securdomino.eu

DURATION: Start: 01/10/2021
End: 30/09/2025

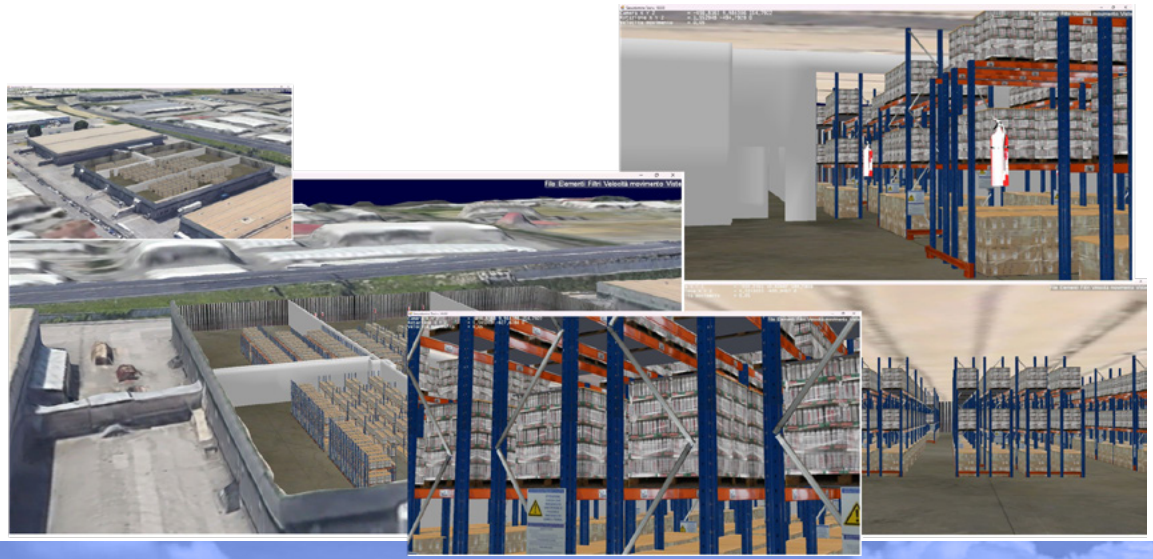
BUDGET: Total Budget: 1,586,206€
EU Contribution: 834,681€

Seveso sites: assessment of integrated safety-security hazards and risks and related domino effects

Chemical and process plants, energy facilities, oil and gas installations and industrial facilities are the potential target of physical and cyber-attacks. These may trigger cascading 'domino' effects such as the release of flammable, explosive, toxic or noxious substances into the environment, and accidents in other areas of the plant not initially attacked.

Security-related threats could affect coasts, rivers, lakes and densely populated areas at regional and national scale. The Major Accident Reporting System reported 557 accidents in EU for the period 1990-2020; 23 of these accidents resulted in domino effects causing €1.1 billion of damages and €3.2 million of environmental damage. The European Program for Critical Infrastructure Protection promotes the prevention, preparedness and response to terrorist attacks to energy and transport installations. The European Seveso-III Directive (2012/18/EU) asks for an assessment of the domino effects focusing on safety and related issues.

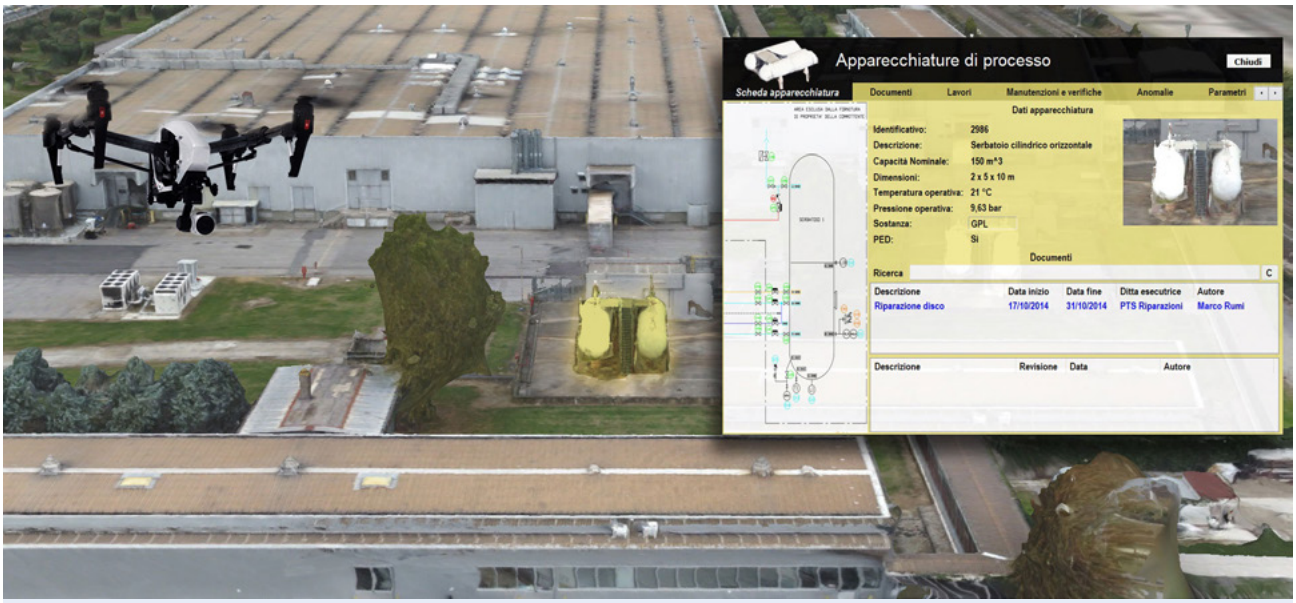
LIFE SECURDOMINO innovates and improves plant inspection practices, bringing to an optimized monitoring of Safety/Security aspects in Seveso establishments and, consequently, obtaining significant benefits to environment and resident population.



Main actions:

Development of a software tool that helps industries and other plants falling under the obligation of the Seveso-III Directive in the integrated safety/security assessment of hazard and risks and related domino effects:

- three-dimensional (**3D**) analysis of process plants to enhance visualization and monitoring
- real-time (**RT**) connection of input parameters to evaluate the risk status

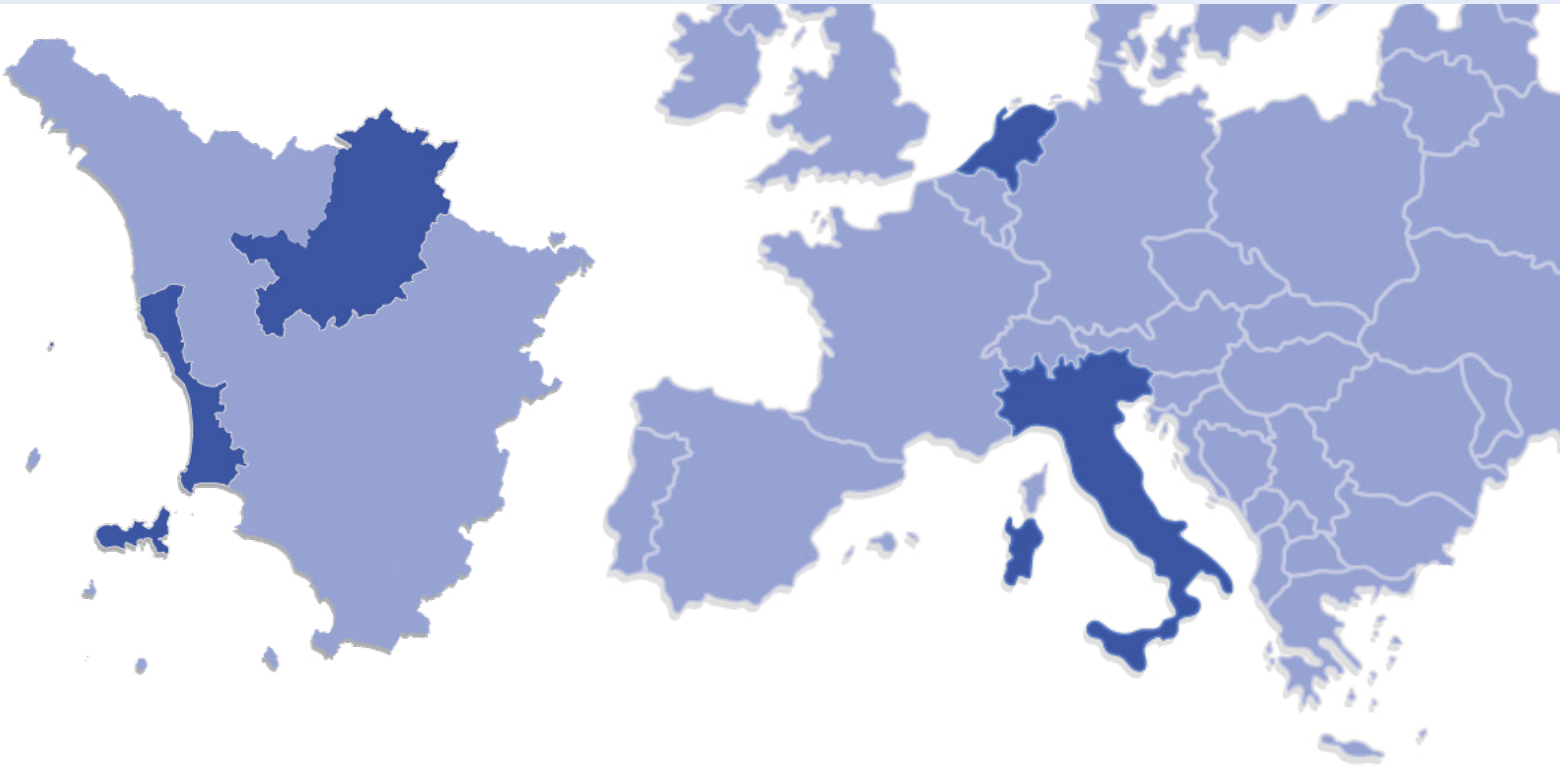


The tool consists of: a) plant inspection by aerial photogrammetry drone;
b) **3D** reconstruction of the plant on a graphic interface;
c) association of **RT** (process conditions, maintenance status, alarms, etc.) and documentation (certificates, permit to work,) to each mapped element;
d) evaluation of probabilities and consequences of accidents, given real time and/or user input data;
e) hazard-risk assessment and visualization of possible dominos following safety/security events;
f) RT mapping of barriers and their performance supporting emergency response.

- Tool parallel testing in 3 industrial DEMO sites:
  DEMO1 - Costieri D'Alesio (Livorno, Italy),
  DEMO2 - Bolton Group (Manetti & Roberts) (Calenzano, Italy),
  DEMO3 - Wilhelmsen Ships Service (Rotterdam, the Netherlands)

- Improvement of the safety-security aspects: DEMO sites vulnerability and risk has been reduced through the tool application improving the safety-security status.

- Environmental benefits quantified through specific project KPIs (Key Performance Indicators).



Partners

The Department of Civil and Industrial Engineering – University of Pisa (DICI - UNIPI) coordinates the project and develops specific models for the 3D-RT assessment of integrated safety-security threats for Seveso Sites.

DataCH Technologies (DataCH) designs and manufactures modular computer systems, specializing in the development of software for the management of safety and security in the port and industrial sectors.

Agenzia Regionale per la Protezione Ambientale della Toscana (ARPAT) is the Tuscan regional agency for environmental protection and the public authority responsible for enforcing Seveso Directive in Tuscany, participating in licensing and inspection of all regional Seveso sites.

The *Institute of Security and Global Affairs – Leiden University* is a scientific institute that specializes in security issues and crisis management.

Crisisplan B.V. is a Dutch organization (SME) of dedicated crisis professionals supporting the replication of the project in the Netherlands.

Project objectives

1) **Development of the software tool for the assessment of integrated safety-security hazard and risks and related domino effects in Seveso sites.** Models and barriers performance data implemented in the model have been reported in an open web repository. The tool is intended for use by companies, consultants and competent authorities involved in the assessment, control and management of major accidents, especially dealing with security scenarios;

2) **Tool Demonstration in 3 industrial DEMO sites.** DEMO1 - Costieri D'Alesio S.p.A. (Livorno, IT) is a petroleum tank farm that stores and handles finished products in large amounts (gasoline, diesel, fuel oil, etc.). DEMO2 - Bolton Group (Manetti & Roberts) (Calenzano, Italy), operates in the industry of cosmetics, personal care, and homecare, the main activities taking place in the plant are the production and packaging of cosmetics. DEMO 3 -Wilhelmsen Ships Service (Rotterdam, the Netherlands) stores and distributes marine products and marine chemicals directly to customers in the Netherlands as well as to other Wilhelmsen hubs and sites globally. The DEMOs feature different capacity, materials, locations, thus they enable picturing all possible applications of the tool in different EU Member States, deriving information for the implementation of Seveso and Environmental Protection Directives;

3) **Improvement of the safety-security status** of the DEMO sites through the tool application;

4) **Reducing time and staff effort** for planning plant inspections and monitoring safety-security barriers;

5) **To raise awareness** of regulators, competent authorities, industrial managers and consultants on prevention and mitigation of domino effects by external acts of interference and to **integrate S/S in plant management**;

6) **Lay the foundations for replicating the system** in the 53 Seveso sites in Tuscany (IT) and 197 sites in North Brabant and South Holland (NL);

7) **Extend the tool to other non-Seveso sites**, such as manufacturing, food processing, water treatment plants, etc.

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Development of fragility models for process equipment affected by physical security attacks

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ARTICLE INFO

Keywords:
Security Vulnerability Assessment
Bayesian Networks
Fragility models
Major accident hazard
Security management
Physical Protection System

ABSTRACT

The vulnerability of chemical and process facilities toward physical security attacks depends on the equipment resistance against such attacks and on the performance of Physical Protection Systems (PPS) in place. To enhance the protection against intentional attacks, the development of quantitative vulnerability metrics is essential, nevertheless current standard approaches only offer qualitative or semi-quantitative evaluations. The aim of the present work is to develop a quantitative methodology for the assessment of chemical and process facilities vulnerability towards external acts of attackcasson. The proposed methodology is based both on the evaluations of equipment structural integrity in response to different types of specific impact vectors characterizing intentional attacks and on the quantitative performance assessment of related PPS. In particular, specific fragility models were developed for impact vectors associated with improvised explosive devices, firearms, and secondary weapons. The novel fragility models were implemented in a comprehensive security vulnerability assessment (SVA) based on Bayesian Networks, in which the contribution of PPS performance was also considered. A case study was defined and analyzed to exemplify the application of the proposed approach. The results obtained allowed for the identification of the most critical security-related escalation scenarios and thus for an improved quantitative SVA.

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Probabilistic assessment aimed at the evaluation of escalating scenarios in process facilities combining safety and security barriers

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ARTICLE INFO

Keywords:
Physical protection system
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Event tree analysis
Domino effect

ABSTRACT

Over the last twenty years, physical security threats to chemical and process facilities became more and more relevant all around the world. Intentional attacks have the potential to trigger severe escalation scenarios. However, in literature there is not a comprehensive and consolidated approach to account for the effect of physical protection systems (PPSs) in the framework of conventional process safety analysis and to consider their contribution with the prevention and mitigation actions of safety barriers. Therefore, the aim of the present work is to develop a probabilistic study dedicated to chemical and process facilities accounting for the combined contribution of safety barriers and PPSs in the prevention of cascading events triggered by security attacks. The quantitative performance of PPSs was characterized in terms of availability and effectiveness, building a specific data repository. The performance data obtained were included into event trees, in which safety barriers were implemented. The analysis of an industrial case study demonstrated the potentiality of the methodology in analysing complex escalation scenarios, identifying the critical PPS elements and, at the same time, showing the critical role of safety barriers in protecting against scenarios triggered by security attacks.

Symbols and Units

AIT	Adversary Intrusion Time, s	P_{fd}	Probability of Successful Intervention of the Emergency Team, -
ERT	Emergency Response Time, s	Q_{HF}	Heat load due to the fire, W/m^2
HEP	Human Error Probability, -	r_c	Material Corrosion Rate, mm/y
NHEP	Nominal Human Error Probability, -	t_{as}	Alarm Assessment time, s
P_{as}	Probability of Assembly Errors, -	t_d	Detection time, s
P_d	Probability of Damage, -	t_{delay}	Delay time accumulated by the intruder along the path, s
P_{deg}	Entry Gate Probability of Degradation, -	t_{cl}	Material thickness, mm
P_{id}	Intrusion Detection Probability of Failure, -	t_{path}	Time to walk the path, s
P_f	Probability of Failure, -	T_r	Rated Time, y
P_{fCCTV}	CCTV Probability of Failure, -	t_{task}	Duration of the final task performed by the intruder, s
PFD	Probability of Failure on Demand, -	η	Effectiveness, -
P_{fg}	Fence Probability of Failure, -	η_{id}	Intrusion Detection Effectiveness, -
P_{fg}	Entry Gate Probability of Failure, -	η_{CCTV}	CCTV Effectiveness, -
P_{HL}	Probability of High Level of training, -	η_{fd}	Fence Effectiveness, -
P_{inch}	Intrusion Detection, -	η_{fg}	Entry Gate Effectiveness, -
		η_{HL}	High Level of training Effectiveness, -

Abbreviations: AIT, adversary intrusion time; AS, attack scenarios; CCTV, closed circuit television; ERT, emergency response time; ET, event tree; ETA, event tree analysis; FTA , fault tree analysis; HEP, human error probability; HRA, human reliability assessment; IED, improvised explosive device; NHEP, nominal human error probability; PFD, probability of failure on demand; PPS, physical protection system; PSF, performance shaping factor; QRA, quantitative risk assessment; SB, safety barrier; SIMS, security risk management system; SRA, security risk assessment; SVA, security vulnerability analysis.

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Real-Time Assessment of Integrated Safety-Security Scenarios Triggering Cascading Events in the Process Industries

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Industrial sites processing and storing hazardous chemicals can be attractive targets of malicious acts of interference. The consequences successful intentional attacks to chemical facilities can be severe and could escalate generating domino effects, potentially affecting people and the environment. Moreover, intentional attacks have a dynamic escalation that is not well depicted by conventional analyses, which are instead static. This works focuses on the development of a comprehensive tool for Integrated Safety-Security risk assessment and related domino effects based on a three-dimensional (3D) real-time approach. Firstly, the plant is inspected using a drone to generate the graphic interface of the tool, which is the 3D reconstruction of the plant. Real-time data are associated with each mapped element, e.g., pressure/temperature conditions. The tool allows for the evaluation of probabilities and 3D consequences of accidents given real time and/or user input data. Potential domino effects of integrated safety-security scenarios will also be included in the tool, allowing for the mapping of plant vulnerability, risk and supporting the evaluation of weaknesses and need of additional countermeasures. In order to provide a sample application, a simplified version of the tool was used on a case study.

1. Introduction

Following the events of 09/11, protecting process facilities storing or processing high amounts of hazardous substances from malicious acts of interference became a concern for both industry and institutions (Baybutt and Ready, 2003). A successful intentional attack might generate the so-called domino effects, i.e., the propagation of the accident among multiple equipment and assets (Landucci et al., 2013). Security science applied to the protection of chemical installations examines the modes and effects of intentional attacks. Security assessment is regulated in Europe only for critical infrastructures or international port facilities; intentional attacks are in fact not explicitly contemplated in the European Seveso-III Directive 2012/18/EU on the control of major-accidents hazards involving dangerous substances in fixed process facilities. Still, security science is not unrelated to operational safety, which focuses on unintentional events. Indeed, these two disciplines are linked by the presence of domino effects and by the intervention of safety barriers in security scenarios.
Nevertheless, the tools currently available for industrial application may not be adequate to cope with the challenge of managing safety and security concerns in a coordinated manner, as quantitative comprehensive approaches are still lacking. Therefore, the development of Integrated Safety-Security (ISS) approaches is necessary to reduce the vulnerability of people and the environment to these threats. Given the dynamic nature of domino effect accidents and the different kind of escalation of security events, ISS approaches may benefit from dynamic real-time approaches (Marroni et al., 2022), which can capture the detailed transient evolution of the scenario and its three-dimensional (3D) features. Dynamic and 3D approaches are also beneficial for the

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Development of equipment fragility models to support the security management of process installations

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A successful intentional attack to a chemical facility, where significant quantities of hazardous substances are stored and processed, might result in severe consequences and cascading events. The development of quantitative vulnerability metrics is essential to enhance the protection against external attacks, but standard approaches offer at most semi-quantitative evaluations. The aim of this work is to develop a quantitative methodology for the evaluation of attack success likelihood, which is expressed in terms of vulnerability. Vulnerability depends on the performance of Physical Protection Systems and equipment resistance against external attacks. Fragility models for process equipment exposed to military and improvised explosives were reviewed and tailored to security scenarios. A case study was defined and analyzed to exemplify the model application. Firstly, vulnerability has been evaluated using the improved fragility models; secondarily, literature conventional approaches were adopted. Based on the obtained results, the present study contributes to the identification of the more critical security-related scenarios and to the definition of key strategies for security management in process facilities.

Keywords: Physical Security, Security Vulnerability Assessment, Probabilistic assessment, Fragility models, Security management, Major accident hazard.

1. Introduction

The process industry is not unrelated to security matters; actually, chemical facilities, where relevant quantities of hazardous chemicals are stored or processed, may be possible targets intentional attacks (van Staalduinen et al. 2017). Security concerns for chemical facilities revolve around both physical and cyber-attacks, as demonstrated by available analyses of intentional attacks occurred in recent years (Casson Moreno et al. 2018; Iaiani et al. 2021). Nowadays, global affairs show that the risk of attacks at industrial infrastructures and chemical facilities is ubiquitous as part of violent conflicts in highly industrialized regions. Global and regional efforts were made to address security issues.

The European legislation does not yet address the need for a security related analysis or countermeasures. On the other hand, international security standards are available for the evaluation of security risk and vulnerabilities (American Petroleum Institute 2013; Garcia 2006), and can provide guidance to analysts and plant managers.

Currently available approaches do however present some criticalities. Firstly, the methodologies offer at-most semi-quantitative metrics; the development of quantitative techniques may help to identify weaknesses of process facilities and provide guidance on security management strategies.

Results and impacts

	**1 software tool** (LINK, QR?) allowing for the comprehensive assessment and mapping of vulnerability and risk indexes for Seveso sites. The **software 3D interface** is based on drone inspection of industrial sites.
	**1 open web repository** (LINK) of models for the assessment of process equipment fragility given different types of attack modes and the presence of multiple safety/security barriers, of which performance data are reported.
	**1 handbook** to support the use of the tool and the communication of vulnerability and risk results in two specific contexts (Italy and the Netherlands).
	**2 innovative procedures for Seveso sites inspections** consistent with EU and national legal frames (1 for Italy and 1 for the Netherlands) and a guidance book to extend them to other EU-MS.
	**3 DEMO sites applications**, located in two different countries (Italy and the Netherlands), providing exemplification of the results that may be obtained in different national regulatory frameworks and plant types, supporting the identification and monitoring of critical safety-security barriers, in order to prevent domino effects.
	**Decrement of DEMO sites vulnerability** (at least **40%** each) and of **risk** (at least **20% each**) with respect to the initial situation, due to the implementation of LIFE SECURDOMINO.
	**1 set of guidelines and effective actions to raise awareness** (link) related to the integration of safety-security in the assessment of major accident hazards; this will constitute a relevant support in the revision and improvement of current regulatory framework at EU-MS level (guidance for the evolution of the Seveso directive, land use planning, critical infrastructure protection, etc.).
	**1 business plan** for the commercialization of the tool supporting technical safety-security studies in Seveso establishments.

LIFE SECURDOMINO innovated and improved plant inspection practices, bringing to an optimized monitoring of safety-security aspects in Seveso Sites. Consequently, site vulnerability and risk indexes in the DEMO sites have been reduced, bringing significant benefits to the environment and resident population. After the project conclusion, the experience obtained with the DEMOs facilitates and enables the extension of the procedure in the considered regions of interest, potentially affecting the risk monitoring and reduction of other 53 Seveso sites in Tuscany (IT) and 197 sites in North Brabant and South Holland (NL). In long-term perspective, the foreseen regional extension of the procedures may enable the development of national and EU implementation, thus affecting the existing ~12,000 Seveso establishments.

The results of the project are communicated and disseminated to industries, local authorities and agencies responsible for safety and environmental inspections to the plants with the participation to **7 specific conferences, 4 dedicated events organized,** and **4 scientific publications** on international peer reviewed Journals.

LIFE SECURDOMINO helping the climate

Chemical and process facilities may be object of external attacks, leading to the escalation of cascading events and domino effects, with massive impact on climate change. The Major Accident Reporting System (eMARS) reports 557 major accidents in EU in 1996-2020, 23 of which resulted in a domino effect with massive releases of hazardous materials with direct impact on global warming, rain acidification, and eutrophication potential.

The Buncefield accident alone (UK, 2005) caused massive fires and explosions, with estimated 0.1-0.2 Mt of CO_2 in 5 days (AEA/ENV/R/2168, 2006). This figure is dramatic compared, for instance, to the total greenhouse gas emissions associated with petrochemical industries worldwide, which is about 1 MtonCO_2/day (Intergovernmental Panel on Climate Change, 2005).

Therefore, prevention and mitigation of major accidents, especially due to domino effects, is of utmost importance to reduce the impact of industrial activities on climate change. The LIFE SECURDOMINO project aims at developing strategies for enhancing the resilience of industrial plants against external attacks, reducing the vulnerability and risk associated with massive release of hazardous substances.

Specific climate-related indicators were monitored during the four years of the project, as the benefit in vulnerability reduction in the 3 DEMOs (i.e., 40% in each site) will decrease the potential CO_2 emissions expected due to the escalation of fires/explosions induced by security related dominos, with a reduction of 29 t/y. Therefore, LIFE SECURDOMINO contributes to the limitation of industrial systems affecting climate change, and under a more general perspective, it contributes to sustainable industrial development.

LIFE SECURDOMINO helping biodiversity

Domino effects and, more in general, major accidents triggered by external acts of interference may significantly affect the ecological integrity of large areas due to the release of chemicals into the environment. Past accidents demonstrated that conventional technical solutions provided to avoid their spread in the case of conventional industrial accidents are likely to be inefficient in case of escalation of cascading events.

Among the 557 major accidents in EU in 1996-2020 (source: eMARS), 23 resulted in a domino effect with massive releases of hazardous materials with direct impact on biodiversity.

Among the most critical major accidents experienced in Europe, the Buncefield accident (UK, 2005) caused the release of about 10,000 t of liquid hydrocarbons and of about 68 million L of firewater, contaminating more than 1ha of groundwater. Moreover, the air quality was affected in the vicinity of the accident, threatening biodiversity, as a 33% increment of NOx was registered in the monitoring, with proportional worsening on the lichen biodiversity index (LBI).

The cyanides spill following the Baia Mare accident (Romania, 2000), caused massive impact on the ecosystem, with total loss of the phyto- and zooplankton communities in the Somes river.

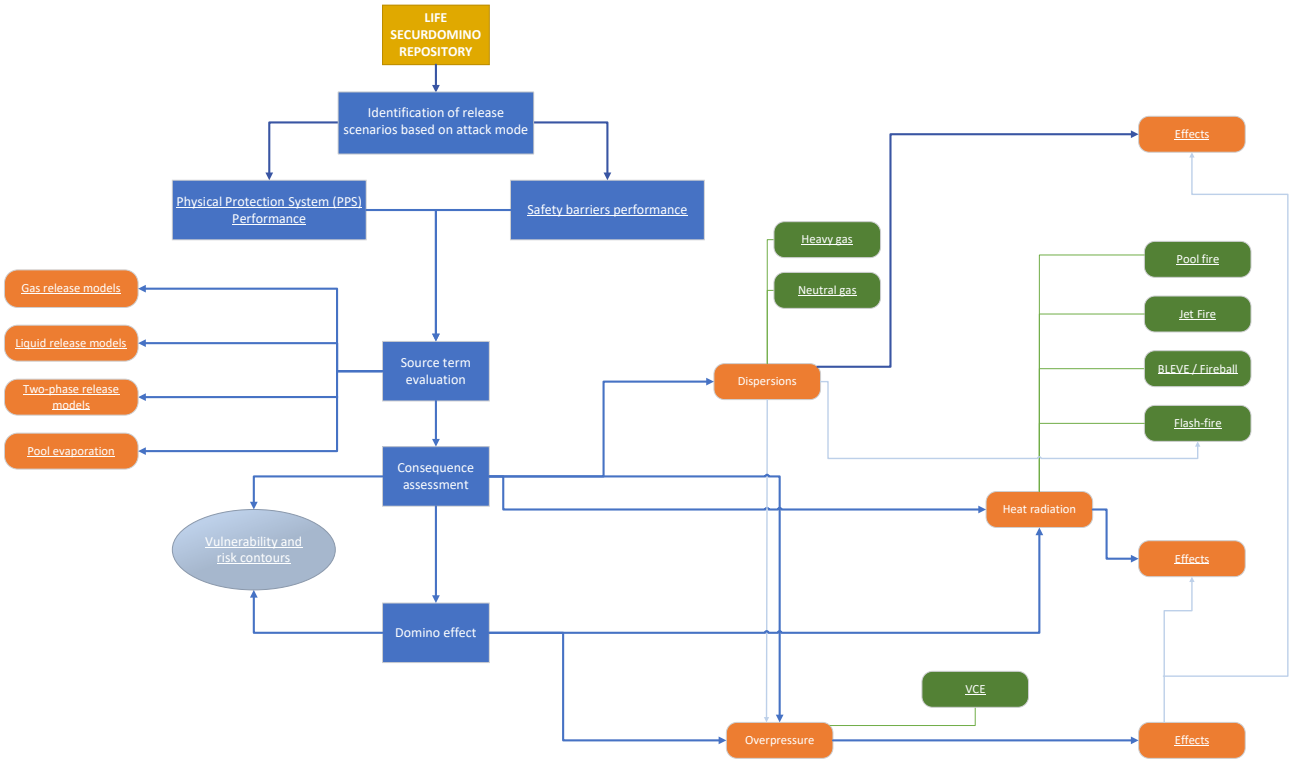
The prevention, preparation and mitigation of domino effects supported by the developed LIFE SECURDOMINO tool are expected to avoid or reduce the release of hazardous chemicals and emissions, thus resulting in potential improvement of biodiversity indexes, such as: the LBI and the Multilevel Biodiversity Index both related to air quality. These indexes will be monitored thanks to the decrement of NOx emissions (ANPA, 2009). The vulnerability reduction of the 3 DEMOs reduced the potential NOx emissions in case of accident by 7 kg/y. Moreover, potential spills of chemicals affecting soil and watercourses are expected to decrease by 11 t/y.

Therefore, the identification and risk assessment of integrated safety-security scenarios as well as the investigation of sustainable proactive solutions and reactive strategies to minimize their consequences are relevant for the protection of biodiversity.

Future scenarios

Project continuation

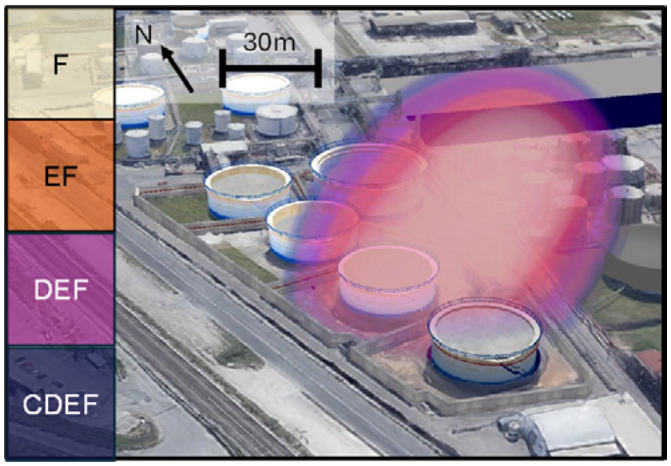
Datach will develop and commercialize the tool in the Italian framework, while CRISISPLAN will implement possible commercialization in the Netherlands. A business plan is set as one of the actions. Industrial stakeholders will benefit from the tool and handbook developed to comply with Seveso Directive and to monitor safety/security barriers status, reducing overall monitoring and accident-related costs.
Data/metadata are available on an open web repository (LINK) for **further update and customization**, including results of further research and adaptation to future regulations. To promote the deployment of the tool, further dissemination & demonstration actions are foreseen in the framework of the **After LIFE Plan**. It will allow, based on financial resources of the partners only, the continuous update of the project results, and will allow the sharing of any further enhancement of the tool in the period five years after the project end.
ARPAT is the **public authority in charge of applying Seveso Directive in Tuscany**, participating in licensing and inspection of all regional Seveso sites. Its commitment into the project provides support to the development of the methodology.



Future scenarios

Project replication and transfer

LIFE SECURDOMINO tool is intended to be used again in the same way and for the same purposes by other entities and sectors during and after the project end. Stakeholders involved in the project will be invited and solicited to actively participate in this testing stage, thus **enlarging the demonstration phase** to a wider number of different environmental situations and scenarios.
The involvement of Italian Dutch competent authorities for Seveso inspections will enable the replication in other Seveso sites, with possible extension at national level. Furthermore, the tool is designed to be open and flexible, to be easily transferred to other industrial sectors and activities, contributing to improving **land-use planning** around multiple industrial sites, with crucial impacts people and environment. The transfer of the methodology and of the tool to other contexts, i.e., not specifically regulated by Seveso Directive such as manufacturing plants, food processing, water treatment plants, is included.



Facilitation of Seveso directive implementation

The assessment of intentional domino effects and **safety-security integration** is not explicitly covered by Seveso directive. The project will overcome this limitation and benefit from the synergy with other EU regulations. In particular, the Directive on Critical Infrastructures protection (2008/114/EC) and the guide to the enhancement of port facilities security (2004/725/EC) will be used to extend the protection measures adopted in other sectors to the chemical facilities. Moreover, LIFE SECURDOMINO is in line with the EU Action Plan COM (2017) 610 enhancing preparedness against chemical, biological, radiological and nuclear security risks, offering a specific adaptation to the industrial chemical sector. Finally, the tool will provide an integrated approach to prevention and control of accidental emissions into air, water and soil, in accordance with Industrial Emissions Directive (2010/75/EU).

The open and flexible nature of the tool will support a harmonized management of integrated safety-security scenarios, a uniform approach towards **multi-risk mapping in the EU**, and the synergy among the aforementioned regulations.
The approach, open and flexible, is susceptible to be applied to other industrial sectors and activities, contributing to improving land-use planning around multiple industrial sites, with crucial impacts on the population and environment. Finally, local national and EU regulators, industrial companies and consultants targeted by extensive dissemination activities for project uptake and **awareness raising on safety and security** of chemical and process industry, to be benefit of EU environment and Citizens. The approach and implementation of the LIFE SECURDOMINO actions will lead to tangible environmental benefits both during project duration and 5 years after the end of the project.

Networking

A networking activity was carried out with other LIFE and non-LIFE projects addressing themes similar to those of LIFE SECURDOMINO. This activity aims to encourage the exchange of experiences, knowledge, methodologies on project themes and the dissemination of project results. Networking activities were realized through remote contacts, on-site visits, and among a specific LIFE Networking event (11/04/2024 in Pisa) organized by UNIPI.

These are the project that established a collaboration with the LIFE SECURDOMINO project:

- INTREPID PROJECT https://intrepid-project.eu/
Both projects are cofinanced by EU and working on tools for real time disaster assessment and emergency management.
SECURDOMINO tool predicts integrated safety-security hazards and risks and related domino effects, for the prevention of disasters; whereas the INTREPID system assess and monitors disaster areas, to minimise disaster effects, making rescue operations safer, faster and more efficient.
Thanks to the networking actions, the two projects are exchanging experiences on tool design, aiming at increasing the prediction capacities of the tools.
LIFE SECURDOMINO participated in the third and last pilot test of the INTREPID platform, which took place in Madrid, in September 2023. The test included a major explosion occurred in an hospital, provoking fire and structural damages to the building. Several unconscious persons were reported throughout the area, raising suspicion of additional chemical contamination.
Also, LIFE SECURDOMINO will take part in the final event of the INTREPID project in October 2023.

- LIFE AUGIA https://www.life-augia.unimol.it/
Both projects are cofinanced by EU in the framework of the LIFE programme and both aim at developing strategies for the sustainable development. More specifically, SECURDOMINO focuses on safety aspects of industrial facilities and supported the partners of AUGIA in verifying safety aspects associated with the potential hazards related to syngas. The synergy among the two projects enabled for testing the models and barriers for safety/security assessment available in the open web repository developed by SECURDOMINO partners and, at the same time, to effectively develop the safe design of AUGIA gasifier.

- LIFE3H https://www.life3h.eu/
The LIFE3H project will create, test and replicate 3 Hydrogen Valleys (HV) in central Italy starting from the construction of buses powered by excess H2 from local industrial production, thus closing the loop at a local level. Transport is a major contributor to air pollution, emitting 32% of CO2 emissions in the EU. The need for more environmentally friendly mobility solutions is inevitable. Hydrogen is among the most promising decarbonization options to provide sufficient energy for long-range and high payload transport due to its superior energy density nature. However, safety concerns are associated with the high flammability of hydrogen are still an open issue. The LIFE SECURDOMINO tool may be extended to capture the dynamic risk profile hydrogen valleys and supporting the real-time assessment of safety-security threats in these facilities.

Publications

Marroni G., Casini L., Kuipers S., Dentone D., Verre M.M., Overdijk W., Moreno V.C., Landucci G. Real-Time Assessment of Integrated Safety-Security Scenarios Triggering Cascading Events in the Process Industries (2023) Chemical Engineering Transactions, 99, pp. 349 - 354, DOI: 10.3303/CET2399059

Marroni G., Casini L., Bartolucci A., Kuipers S., Casson Moreno V., Landucci G. Development of fragility models for process equipment affected by physical security attacks (2024) Reliability Engineering and System Safety, 243, art. no. 109880, DOI: 10.1016/j.ress.2023.109880

Casson Moreno V., Marroni G., Landucci G. Probabilistic assessment aimed at the evaluation of escalating scenarios in process facilities combining safety and security barriers (2022) Reliability Engineering and System Safety, 228, art. no. 108762, DOI: 10.1016/j.ress.2022.108762

Marroni G., Moreno V.C., Kuipers S., Verre M.M., Landucci G. Securing Chemical Facilities Against Intentional Attacks: a Bayesian Network Approach for Asset Risk Assessment (2024) Chemical Engineering Transactions, 111, pp. 487 - 492, 10.3303/CET24111082

Dissemination in conferences

Loss Prevention Conference 2022, organized by the EFCE International Symposium on Loss Prevention and Safety Promotion in Process Industries, Prague, Chech Republic, 5-8/06/2022

32nd European Safety and Reliability Conference ESREL conference, organized by the ESRA European Safety and Reliability Data Association, Dublin, Ireland, 31/08/2022

61st ESREDA conference, organized by the ESReDA European Safety and Reliability of Data Association, Turin, Italy, 22-23/09/2022

ICHEAP16, 16th International Conference on CHEMICAL AND PROCESS ENGINEERING organized by the AIDIC Italian Association of Chemical Engineering, Naples, Italy, 21-24/05/2023

33rd European Safety and Reliability Conference ESREL conference, organized by the ESRA European Safety and Reliability Data Association, Southampton, UK, 3-7/09/2023

European Researchers' Night event Bright Night -Marie Skłodowska-Curie GA 101061075, organized by the University of Florence, Pisa and Siena, University for foreigners of Siena, School of Advanced Studies Sant'Anna, Scuola Normale Superiore, School for Advanced Studies Lucca (IMT), in collaboration with National Research Council (CNR), National Institute for Nuclear Physics (INFN), National Institute of Geophysics and Volcanology (INGV), European Gravitational Observatory (EGO), National Institute of Astrophysics (INAF). Pisa, Italy29/09/2023

34th European Safety and Reliability Conference ESREL conference, organized by the ESRA European Safety and Reliability Data Association, Krakow, Poland, 23-27 June 2024

CISAP 11 - International Conference On Safety & Environment In Process & Power Industry, , organized by the EFCE International Symposium on Loss Prevention and Safety Promotion in Process Industries, Naples, Italy, 15-18 September 2024

SECURDOMINO project

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Coordinating partner:

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www.unipi.it

Associated partners:

DataCH Technologies S.R.L. (DataCH)
Livorno, Italy
www.datachtechnologies.it

Agenzia Regionale per la Prevenzione, l'Ambiente e l'Energia della Toscana (ARPAT) Firenze, Italy.
www.arpat.toscana.it

Universiteit Leiden (LEIDENU)
Leiden, the Netherlands
www.universiteitleiden.nl

Crisisplan BV (CRISISPLAN) Leiden, the Netherlands
www.crisisplan.nl/en/

Further information here:

www.securdomino.eu

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