This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 603960.

POLICY BRIEF

October 2015
www.infrarisk-fp7.eu

Critical Infrastructure Protection and Natural Disaster Risks in Europe

INFRARISK:
"Novel indicators for identifying critical INFRAstructure at RISK from natural hazards"

INFRARISK focuses around improving operational analysis to reduce the risk to the infrastructure network, by developing optimal stress testing techniques

1. Introduction

Disasters and climate risks have a major impact on the economy as well as on the security and well-being of citizens. Disasters related to natural hazards continue to grow in number, intensity and impact in Europe and elsewhere. In the last decade, natural disasters have severely affected not only populations worldwide but also have had severe adverse effects on the economy. Society has become more vulnerable because of the increasing rates of higher concentration of high-value assets and Critical Infrastructures (CI) in areas vulnerable to major disasters.

In general, extreme geological and hydro-meteorological hazards account for most disaster events and the impact on Europe has been significant with natural disasters causing 80,000 deaths and € 95 billion in economic losses over the last decade (European Commission, 2014b).

At present, the increase in the potential for severe and widespread impacts of "extreme" — rare but devastating and very high impact — natural hazards events is not only apparent but also greater than ever before with some of these events being linked to Climate Change. Extreme events can cause severe disruption of national and regional economies, with potential impacts and effects on CI, and capable of causing extremely severe loss of function.

CI failures depend not only on the extreme event but also on the primary failure type of an infrastructure element or system which could lead to cascading failures in local and regional interdependent systems.

A necessary first step for the protection of European critical infrastructures is the effective mitigation of the impacts through the evaluation of the risk, i.e. assessing hazard, exposure, and vulnerabilities, and understanding and evaluating the coping capacity and resilience.

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 603960.

INFRARISK project focuses on developing optimal stress testing techniques to contribute to European CI resilience representing a step change in the approach to critical infrastructure management by improving operational analysis to reduce the risk of the infrastructure network.

INFRARISK addresses the potential impacts of natural hazards such as earthquakes, flooding, and landslides on the European Transportation network TEN-T (road and rail).

2. Disaster risk management and critical infrastructure protection in EU

Strengthening EU economies' resilience to risks and the capacity for disaster prevention and response is amongst the objectives of the Europe 2020 strategy.

One source of critical stresses to CI is the occurrence of natural disasters and its associated impacts. CI was usually public because of their great significance for society. However at present, CI has become components of larger interconnected systems and more and more utilities pass into the hands of private business. In many EU countries large infrastructure is privately owned with no single owner, operator or regulator. This fact increases the complexity of infrastructure systems especially as owners, operators and regulators have generally different goals (Menoni, 2005).

Since 2004 the European Union works towards a common EU approach to the protection of CI. Central is the **E**uropean **P**rogramme for **C**ritical **I**nfrastructure **P**rotection/EPCIP (European Commission, 2006) which included a procedure for the identification of European CI, a common approach to assessing the need to improve protection of such infrastructure, measures to facilitate the implementation of EPCIP, information sharing processes, and the identification and analysis of interdependencies, among other aspects. The Directive 2008/114/EC was the first legal instrument at EU level with a sectoral approach focusing on Energy and Transport. A European Reference Network for Critical Infrastructure Protection (ERN-CIP) has also been created by the Commission with a mission to "foster the emergence of innovative, qualified, efficient and competitive security solutions, through networking of European experimental capabilities".

The new approach of EPCIP incorporates three main work streams: prevention, preparedness, and response

The review of the EPCIP (European Commission, 2012a) provided a general analysis of the elements of CI protection describing the development of risk assessment methodology. Based on the results of this review and considering other elements, the European Commission set out a new approach to ensure a high degree of protection of EU CI and increase their resilience against threats and hazards with a revised and more practical implementation of activities under the three main work streams – prevention, preparedness and response (European Commission, The revised guidelines of the TEN-T should take into account the impact of climate change and of potential natural and man-made disasters on infrastructure

2013a). The new effort aims at building common tools and a common approach in the EU to critical infrastructure protection and resilience, taking better account of interdependencies.

Natural disasters, multi-risk disasters and emerging disaster risks such as the impact of climate change and the implications for infrastructure are addressed in a Commission Staff Working Document (European Commission, 2014a). The main EU policy document specifically targeting adaptation is the EU Strategy on adaptation to climate change (European Commission, 2013b) aimed at contributing to a more resilient Europe at national, regional and local levels.

The European Commission's proposal for a 7th Environment Action Programme to 2020 (7EAP) (European Commission, 2012b) considers adaptation to climate change. For example, the 7EAP requests that projected expansion of transport infrastructure in Europe is compatible with the needs of climate adaptation.

Action 7 of the strategy directly considers adaptation in the transport sector. The strategy mentions that adaptation has already been mainstreamed in legislation in sectors such as transport, but further efforts to ensure effective and efficient mainstreaming will be needed. It also cites the legislative proposal on the EU guidelines for the development of the Trans-European Transport Network (TEN-T).

The revised guidelines of the TEN-T approved in December 2013 (EU, 2013) recommend that the Network developments should take into account the contribution to climate change and the impact of climate change and of potential natural and man-made disasters on infrastructure, and that they (Network developments) shall be planned, developed and operated in a resource-efficient way through, among other things, adequate consideration of the vulnerability of transport infrastructure.

3. CI Risk management approaches: Uncertainty and insufficient knowledge

EU faces challenges in assessing, understanding, and responding to disaster risk. Major risk challenges are those posed by extreme rare events and their effects on critical infrastructure

EU faces challenges in assessing, understanding, and responding to disaster risk. The changes in the intensity and occurrence of the events together with varying vulnerability and increased exposure of high value assets exacerbate the impacts of natural hazards. Major risk challenges are those posed by extreme or rare events and their effects on critical infrastructure.

Extreme rare events are characterized by their low-probability of occurrence and high impact (LP-HI) consequence. Appropriate integrated approaches to assess risk and impacts lack comprehensive databases and/or access to relevant privately owned and operated datasets because of proprietary issues. As such, there is hardly any data in the historical records to assess and understand the risk, and much less to provide in advance a precise estimation of their occurrence and impacts.

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 603960.

Risk management procedures should represent accurately the effect of the fundamental uncertainties about models and parameters.

A critical issue in these cases which deserves special attention is the exhaustive and rigorous treatment of the deep uncertainties— both aleatory and epistemic— which commonly applied probabilistic approaches might involve. The two types of uncertainties relate to different rare events referred to generally as "perfect storms"— involving mostly aleatory uncertainties (randomness) in conjunctions of rare but known events— and "black swans"— representing the ultimate epistemic uncertainty or lack of fundamental knowledge, where not only the distribution of a parameter is unknown, but in the extreme, the very existence of the phenomenon itself— (Paté-Cornell, 2012).

Risk management procedures should be based on research, methodologies, and tools able to account and represent accurately the effect of the fundamental uncertainties about models and parameters. Informed decisions can then be made improving the operational analysis to reduce the risk to the infrastructure network.

In light of these uncertainties, there is the need to develop new methodological approaches and tools for operational decision making, such as adaptive management, incremental adaptation, and the adaptation pathway approach, as well as better understanding of the sensitivity of different adaptation options and decisions on uncertainty.

4. Need to improve CI risk assessments: Stress tests

Redifining risk for critical infrastructure and development of specific tools

In general, the risk assessment methodologies for CI are an adaptation of methodologies that have been used for assessing risks within the confined environment of an organization.

CIs are complex systems which require the assessment of the infrastructure from a holistic point of view. A critical challenge for the protection of CI in Europe is to increase their resilience through a thorough evaluation of different disruption scenarios including cascading effects in interconnected and interdependent systems.

Especially in the case of rare or extreme events — low probability-high impact — a complete risk assessment needs to combine the expected impacts with the likelihood of the scenario. This information can then be used for prioritization of risk mitigation actions.

CI risk assessment methodologies at European level do not match the maturity— in terms of effectiveness and completeness— of their counterparts in other countries (JRC, 2012). Due to the fragmentation of several European infrastructures into several countries with different security measures and security culture, these methodologies have been commonly developed to meet local protection issues.

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 603960.

A challenging goal for CI risk assessment methodologies is to incorporate resilience analysis with prevention, resistance to disturbance, and failure recovery measures as part of a harmonized framework in Europe.

Implement policies for systematic stress tests of CIs in Europe

A challenging goal for CI risk assessment methodologies is to incorporate resilience analysis with prevention, resistance to disturbance, and failure recovery measures as part of a harmonized framework in Europe.

The staff working document of the European Commission on the revised EPCIP (European Commission, 2013a) clearly mentions stress tests as one of the tools to be developed in order to contribute to the improvement of prevention and preparedness in the context of CIs and as improvement measures to be developed in the near future.

Stress tests are central to resilience analysis for extreme rare events. Stress tests allow for the identification of relevant measures that are needed to assure the continuity of services in these cases where the scarcity of data from the small number of such events cannot provide a reliable prediction of similar future events.

Through conducting stress testing on CI's a twofold purpose is served: 1) the severity of a hazard/disruptive event is associated with the potential impact on a system by identifying the operation limits as well as the vulnerabilities of critical infrastructures, 2) it supports the work of managers, stakeholders, and policy makers through providing insight into the impact of such events and by assessing the limits of their infrastructures and systems in such crises involving the core part of the prevention and preparedness work (operators of critical infrastructures and/or the sectoral associations at a higher level).

5 Conclusion

Critical Infrastructure protection faces a number of challenges in Europe, including complex interacting elements. In recent years, disruptions hampering the efficient functioning of economy and society have affected the operation of national, regional and local CI worldwide. Some of these disruptions have resulted from the occurrence of natural hazards. The increased interconnectivity of CI together with the increase in the potential for severe and widespread impacts of extreme natural hazards escalate the urgency for improving risk management methodology and resilience analysis.

The key issue in dealing with protection of CI's is its systemic, interconnected, and interdependent nature. Risk management needs to ensure that vulnerabilities in one sector do not compromise others. In many cases, cross-sectoral interdependencies and also intra-sector equivalents span over a number of European countries (e.g. transport, energy).

Risk governance of CI's at European level remains a main challenge (CIs are run according to different standards across Europe) and can be improved by various technical, management, and organizational strategies.

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 603960.

INFRARISK will contribute to European critical infrastructure resilience on several fronts representing a step change in the approach to critical infrastructure risk management.

The EC strategy in its new approach to the European Programme for Critical Infrastructure Protection further stresses the importance of analyzing the extent to which the European standards and technical specifications for physical infrastructure should be strengthened. (European Commission, 2013a).

Representative case studies considering the impacts of earthquakes, slope failure, mass movement, and flooding on European roads, highways and railroads (TEN-T Core network) will help INFRARISK to establish a stress test framework and a probabilistic modelling approach to achieve:

- **Improvement of risk management approaches**
  Incorporating an exhaustive and rigorous treatment of the deep uncertainties involved in rare extreme events, probabilistic methodologies, and cascading effects.
- **Improvement of operational tools and procedures**
  Incorporating an INFRARISK decision support tool and operational evaluation methodology that can support decision making in a "stakeholder friendly" and transparent way.
- **Understanding the limitations of existing measures**
  Assessing the resilience margins of CI through the developed stress test framework and improving the awareness of the consequences of such events.
- **Contribution to European risk governance of CI**
  Stress test results will help to revise transport standards and management to create more harmonised and consistent technical approaches contributing as well with useful knowledge to disaster risk prevention policies
- **Increased capacity at stakeholder level**
  Operational Analysis Framework considering cascading hazards, impacts and dependent geospatial vulnerabilities with practical software tools and guidelines and training course provisions.

Authors:

This policy brief was written and edited by María-José Jiménez (CSIC) and Mariano García-Fernández (CSIC)

This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 603960.

Contact details:

Dr. M.J. Jimenez C.S.I.C. Madrid Spain.
Email:
mj.jimenez@csic.es

How to quote this document:

Jimenez, M.J., Garcia-Fernandez, M. (2015), "Critical Infrastructure Protection and Disaster Risk Management in Europe", Policy Brief of the INFRARISK project.

More information:

www.infraisk-fp7.eu

REFERENCES

ERNCIP, European Reference Network for Critical Infrastructure Protection (2013): ERNCIP Background Information. Presentation by JRC, May 2013. Available from: http://ipsc.jrc.ec.europa.eu/fileadmin/repository/sta/cinet/docs/erncip/downloads/ERNCIPstandard_presentation.pdf. Accessed 2015 Mar 20.

Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection, Official Journal of the European Union, L345/75.

EU Regulation. (2013). No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU, OJ L 348, 20.12.2013.

European Commission. (2006). European Programme for Critical Infrastructure Protection. COM (2006) 786 final.

European Commission. (2012a). Review of the European Programme for critical infrastructure protection (EPCIP). SWD (2012) 190 final.

European Commission. (2012b). 'Europe 2020: Europe's growth strategy' (http://ec.europa.eu/europe2020/index_en.htm). Accessed 2015 Jan 24.

European Commission. (2013a). A new approach to the European Programme for Critical Infrastructure Protection Making European Critical Infrastructures more secure. SWD (2013) 318 final.

European Commission. (2013b).An EU Strategy on adaptation to climate change' COM(2013) 216 final.

European Commission. (2014a). Overview of natural and man-made disaster risks in the EU. SWD (2014) final.

-European Commission (2014b). The post 2015 Hyogo Framework for Action: Managing risks to achieve resilience. COM(2014) 216 final

-Menoni, S., Pesaro, G., Mejri, O. and Atun, F. (2005): Interface between public and private treatment of «public goods». Background Paper prepared for the 2013 GAR on DRR Geneva, Switzerland: UNISDR. Available from: http://www.preventionweb.net/gar. Accessed 2015 Jan 25.

-JRC (2012) Risk assessment methodologies for Critical Infrastructure Protection. Part I: A state of the art. (http://ec.europa.eu/home-affairs/doc_centre/terrorism/docs/RA-ver2.pdf). Accessed 2015 Mar 15.

-Pate´-Cornell E (2012) On ''black swans'' and ''perfect storms'': risk analysis and management when statistics are not enough. Risk Anal 32(11):1823–1833.