EU-CIRCLE

A pan-European framework for strengthening Critical Infrastructure resilience to climate change

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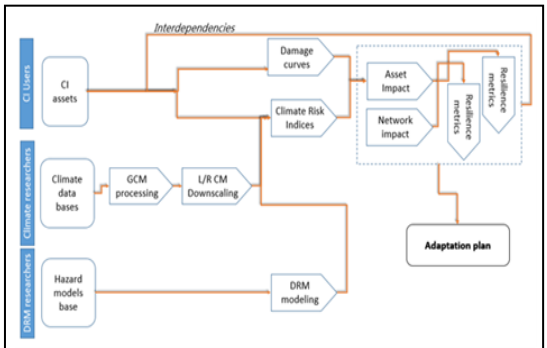
this issue

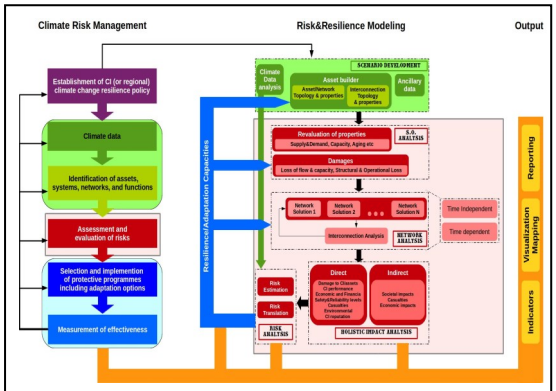
Key Findings

The main aim of the EU-CIRCLE research project is to provide scientific research, analyses and tools to support the development of an infrastructure network(s) that is resilient to today's natural hazards as well as to future climate change. It addresses existing gaps in the knowledge on climate change impacts and adaptation in Critical Infrastructure (CIs) with the aim of promoting better decision-making by CI stakeholders.

EU-CIRCLE is comprised of nine distinct but linked work packages, which address various themes including climate data; risk modelling; and CI resilience and climate change adaptation.



EU-CIRCLE
Methodological Framework



EU-CIRCLE
Climate Risk Assessment Framework
The first step to improving resilience of CI to climate change impacts is anticipating the risks to interconnected and interdependent critical infrastructures .

These research themes are directly tied to the development of the Climate Infrastructure Resilience Platform (CIRP), a standalone and comprehensive software toolbox that is able to accommodate different types of datasets (e.g. hazard, assets, interconnections, fragilities), file formats, and risk analysis algorithms. The CIRP is open, modular and extensible in order to support various risk and resilience assessment analysis tools and will provide users with access to diverse simulation, modelling and risk assessment solutions.

EU-CIRCLE has been exploring the impacts of projected climate change on CI and will be examining how various adaption options can influence the resilience of CI networks, whilst taking into account the various interdependencies present in modern CI networks. This will be achieved through implementation of the EU-CIRCLE risk model and the resilience and adaptation frameworks through CIRP in six case studies involving: extreme dryness and forest fires on electricity and transport networks in France; storm and sea surge at a Baltic Sea Port, Gdynia, Poland; coastal flooding across Torbay, UK; cyclonic pressures and flooding in Bangladesh, and rapid winter flooding Dresden, Germany.

EU-CIRCLE
Resilience Framework
The EU-CIRCLE resilience framework sets out what constitutes critical infrastructure resilience and its key compo-

PROJECT DETAILS

Start date : 01/06/2015
End date : 31/05/2018
Duration : 36 months
Reference : GA no 653824
Call : H2020-DRS-2014

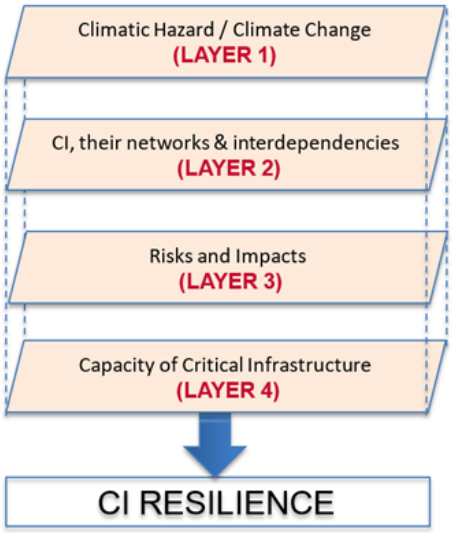
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 653824"

EU-CIRCLE Resilience Framework

Infrastructure plays a vital role in the economic growth, well-being and health of the community and contributes to the overall socio-economic development of modern societies. Destruction of infrastructure can lead to severe economic and social impacts and can also lead to the loss of lives. This is especially true today, in an increasingly interconnected and hence interdependent environment, where welfare and prosperity depends on the continuous and reliable services provided by critical infrastructure. These critical infrastructure interdependencies have become increasingly complex and require a 'system of systems' approach to properly assess and understand the nature of impact resulting in failure and cascading effects on to other related infrastructures. To minimise such impacts and reduce risk, it is vital to identify vulnerabilities and improve the resilience of critical infrastructures.

Critical infrastructure Resilience in the context of EU CIRCLE is defined as the ability of a CI system to prevent, withstand, recover and adapt from the effects of climate hazards and climate change. Having conducted an extensive review of the literature on existing resilience frameworks, EU CIRCLE proposes a novel 4 layered approach to CI resilience: 1) Climatic hazard, climate change; 2) Critical infrastructure, their networks and interdependencies; 3) risks and impacts from climate change; and 4) capacity of critical infrastructure.

The 4 layers in the EU-CIRCLE resilience framework which determine what constitutes critical infrastructure resilience and their key components are summarised briefly below:



Resilience of what – the context which is critical infrastructure, their networks and interdependencies as incorporated in Layer 1

Resilience for what – the disturbance which is climatic hazards, including current and future climate change represented in Layer 2

Risks and Impacts - which includes the consequences of a hazard and the likelihood of the occurrence, detailed in Layer 3

Capacities of critical infrastructure such as the ability to anticipate and reduce the impact; ability to buffer and bear; ability to be repaired easily and efficiently included in the final Layer 4

Resilience parameters i.e. properties that indicate different capacities are also included in Layer 4

The EU-CIRCLE resilience framework thus has multi-dimensional components, incorporating risks and capacities with the focus on critical infrastructure, their networks and interdependencies and climate hazards including current and future climate change.

http://www.eu-circle.eu/

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Cyprus Workshop on "Critical Infrastructure Protection and Climate Change"

The project, which has been running for 22 months, held a workshop in Cyprus on 7-8 March 2017 on the topic of Critical Infrastructure Protection and Climate Change. The workshop was organised by the European University Cyprus, and co-organised with the Cyprus Civil Defence (Cyprus's national contact point for EU CI), with the participation of the Joint Research Centre and local Critical Infrastructure Operators from the energy, ICT, water and public sectors. In total, 50 stakeholders participated in the workshop, which included presentations on the potential impacts of hydro-meteorological hazards on CI, the changing climate in Cyprus and future climate change predictions as well as the EU-CIRCLE risk assessment and resilience frameworks. The second day of the workshop included a table top exercise, where participants engaged in discussions on the predicted impacts of climate change exacerbated forest fires, on climate change risk assessment and on potential response options in interconnected national infrastructures.

Hydro-Meteorological hazards do impact CI

All participating operators recognise that meteorological hazards such as wildfires, extreme temperatures and flooding impact their infrastructure, yet only some of them take risk mitigation actions and preventive measures. Furthermore, no CI operator takes into account climate change and how this can impact the frequency and intensity of extreme events. Through the workshop EU-CIRCLE provided data on future forest fire and meteorological risk based on the RCP 2.6, RCP 4.5 and RCP 8.5 scenarios for the time period 2016 to 2050 in Cyprus, which raised awareness on how climate change will potentially result in increased impacts due to the increase in the frequency and intensity of extreme events.

Energy and ICT most important CI sectors in Cyprus

In discussions on how each CI sector is interconnected and dependent with the other, it became clear that the energy and ICT sectors are the most vital in Cyprus as all CI sectors are dependent on these two. In long-term crises, smooth port-operation becomes critical as entry points of spare parts and equipment. The electricity sector has done the most to build redundancy, with the ICT sector second. All other CI sectors identified that more needs to be done by them to build-in redundancy and that the EU -CIRCLE paradigm of resilience is a useful framework for guiding their efforts.

Climate Change must be taken into account in CI protection plans and interdependencies must be considered under crises situations

Finally, CI participants identified, through discussions of the future forest fire scenarios provided by EU-CIRCLE, that climate change and its impacts on the frequency and intensity of extreme events is something that should be taken into account in their planning with respect to meteorological hazards. Dependencies between sectors are likely to be particularly important during a crisis and this is something that CI operators need to explore further. EU-CIRCLE's work on climate data, risk and resilience modelling is of particular interest to the CI operators to help them take into account extreme events, climate change and interdependencies.

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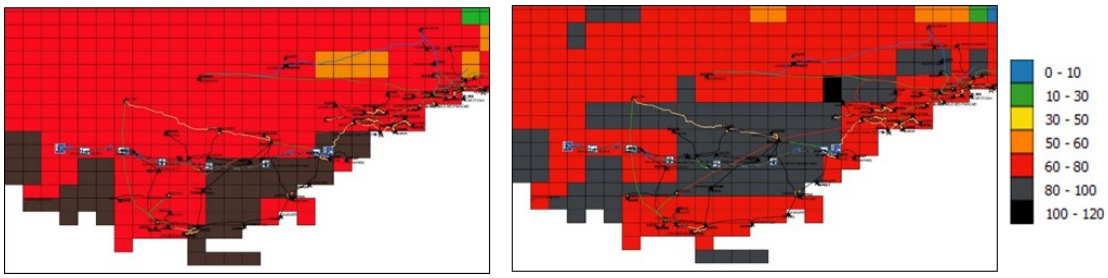
Discussing the impacts of a wilfire in the South-East of France with the Critical Infrastructures operators Case Studies

The French case study aims to analyse the impact of a dry-spell with wildfires igniting simultaneously in the summer 2040 in the South East of France (Provence-Alpes-Côte d'Azur Region), and focuses on the electricity network and the road transportation system (highway network). The risk analysis is conducted using Fire Weather Index projection, derived risk level estimates and historical data sets (localisation of wildfire ignition points for instance). Wildfires are simulated thanks to a fire spreading model (FIRETACTIC) in the fire prone areas and their impact on the critical infrastructures is investigated. On April 4th, 2017, the French partners of the project (Valabre and Artelia), together with the coordinator from Demokritos, gathered the relevant French operators to discuss the impact of climate change and related secondary hazards (i.e dry-spell, heat-wave and forest-fires) on their infrastructures:



- RTE, operating the French electricity transmission network ;
- ENEDIS, operating the major part of the French electricity distribution network ;
- and ESCOTA, operating the highway network.

In addition, fire-fighters from the Var county (département) and the Zonal Operational center also attended the workshop, as the case study scenario will be conducted as an actual Civil Protection exercise to complement the validation of EU-CIRCLE's Climate Infrastructure Resilience Platform (CIRP). This approach of running the case study scenario through CIRP but also in real life will help in fulfilling the operational objectives of EU-CIRCLE of ensuring service continuity, minimising recovery time and leveraging inter-organisational collaboration during crises.

The methodological framework and the functioning of the CIRP Platform of the project was presented to the participants. The physical damages and functional impacts of such hazards not only on the CIs (damages to the network assets, degraded overall performance, economic and financial losses, consequences on safety and reliability levels, as well as on the CI reputation) but also on society at large were examined. The discussions concerning the cascading effects across networks were particularly fruitful as this meeting was the first common gathering of all stakeholders of the case study. The afternoon was devoted to the EU-CIRCLE approach to resilience. In this session, the discussion focused on the choice of relevant indicators and metrics to assess the resilience of the CIs and pave the way towards the identification of relevant prevention and adaptation measures.

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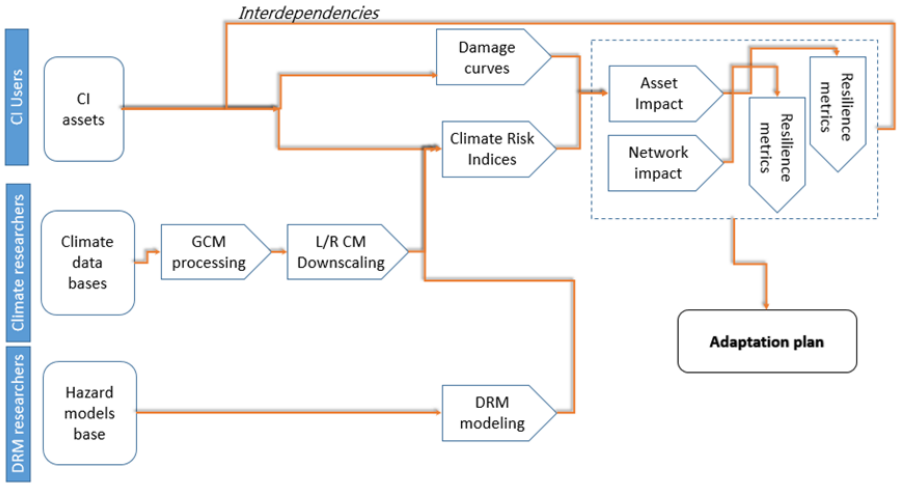
Methodological Framework

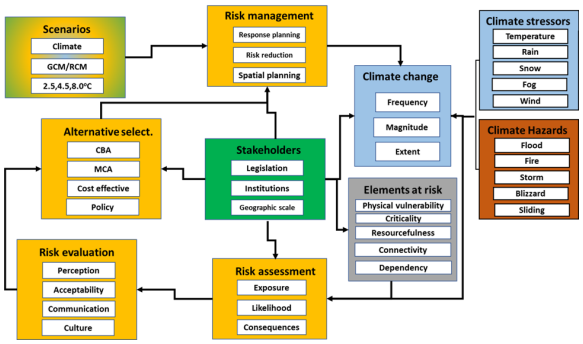
The EU-CIRCLE methodological framework sets out the project's approach on how to assess possible climate change impacts on the operation and capacity of a country's critical infrastructure and to identify and develop appropriate adaptation measures to strengthen the operational resilience of the respective CI.

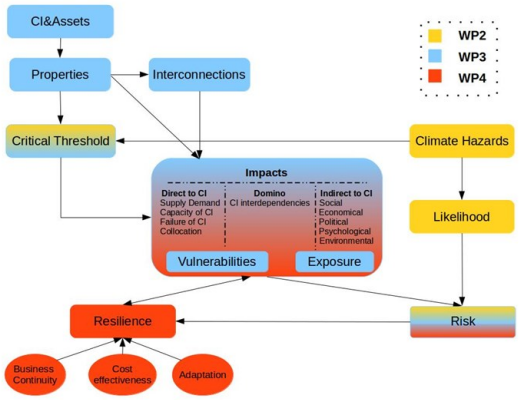
The framework is shown in Figure below. The approach builds on the selection and application of appropriate modelling tools that allows users to evaluate climate related impacts to CI operations and subsequently on society, and define adequate responses focusing on technical aspects (e.g., modifying the design of infrastructures to make them more resistant to an increased intensity of floods), policy and legal elements (e.g., new building codes), financial aspects (e.g., specific funds allocated to support the maintenance of infrastructure), socioeconomic aspects (e.g., relocation or abandonment of infrastructures, change in habits and behavioural patterns associated with the use of infrastructures) and institutional aspects (e.g., awareness raising and capacity building of the infrastructure sector on climate adaptation).



The methodology developed is closely related to a number of initiatives within the Sendai Framework for Disaster Risk Reduction such as:

- improving risk understanding - hazard characterization
- exposure and vulnerability analysis
- risk assessment
- improving institutional capacity on disaster risk reduction
- strengthening Early Warning Systems
- supporting multi-hazard management decisions
- contributing to capacity building for addressing extreme events
- supporting decisions on building new CI, or strengthen and/or expanding existing CIs





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Risk assessment framework

The first step to improving resilience of Critical Infrastructure (CI) to climate change impacts is the identification of the risks of several climate hazards to interconnected and interdependent CIs i.e. risk assessment.

The EU-CIRCLE risk assessment framework includes:

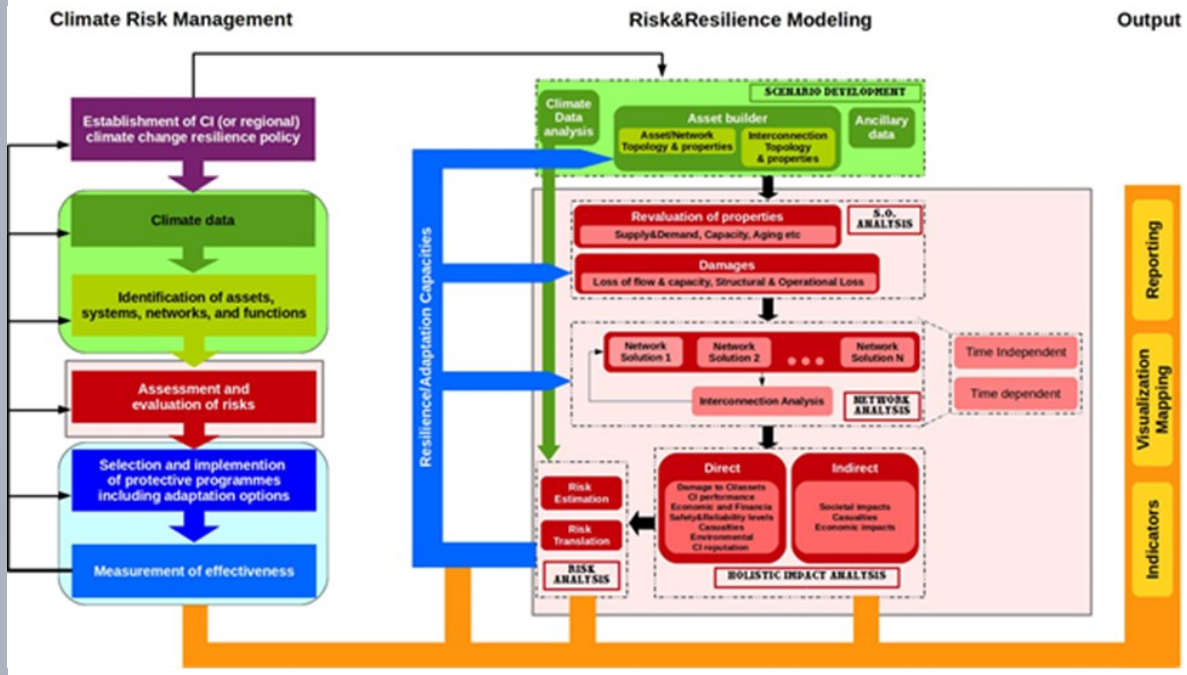
• Assessment of the current risks of a specific climate hazard to a single CI or a CI network or even an area of interest with interconnected and interdependent CI.

• Examination of how climate change may alter risk in the future, or expose new risks. This analysis includes a baseline assessment of the risks to CI assuming no additional adaptation actions under various climate change scenarios, as well as a second assessment which considers how current or future potential adaptation actions will affect the overall scale of risk to CIs in the future under the same climate change scenarios.

• Identification of climate change adaptation or risk mitigation options and definition of priorities. This step examines alternative strategies for mitigating risks to CI and strengthening their resilience such as: enhancing the defences of interconnected infrastructures and implementation of long term adaptation options.

A comparative assessment of these scenarios using well identified criteria (e.g. cost – benefit analysis) will return scientific evidence for supporting informed decision making.

EU-CIRCLE Risk Modelling Framework is set out in Figure below:



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Partners and Data

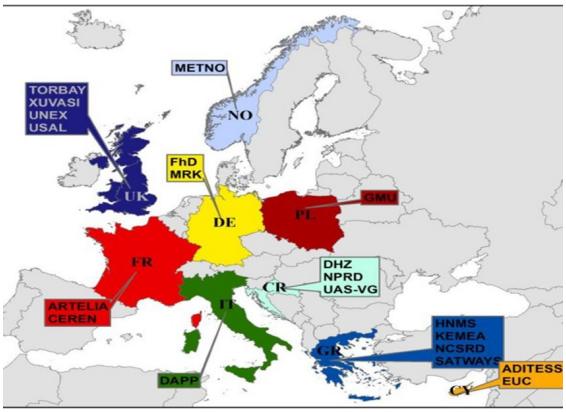
EU-CIRCLE is funded by the HORIZON 2020 programme of the European Commission, under the call: H2020-DRS-2014: "Disaster-resilience: Safeguarding And Securing Society, Including Adapting To Climate Change".

The topic addressed by the project relates to Disaster Resilience & Climate Change. Its duration is 36 months from 1st June 2015 until 30 May 2018. The allocated budget is 7,283,525.00 €. In total 20 partners from 9 EU-countries participate in EU -CIRCLE. An International Stakeholder's Advisory Group has been set up which currently consists of 13 members, from countries across the globe. A workshop was held in May 2016 in Italy where the Advisory group and other stakeholders were able to review the first work of EU-CIRCLE. Further details related to the workshop are available on the EU-CIRCLE website .

Topic: Disaster Resilience & Climate Change topic 1:

Science and innovation for adaptation to climate change: from assessing costs, risks and opportunities to demonstration of options and practices

- **Project Number: 653824**
- **Total Budget: 7,283,525.00 €**



EU-CIRCLE partners

Project Coordinator

Dr. Athanasios Sfetsos

NCSR Demokritos

e: ts@ipta.demokritos.gr
p: +30 2106503403

Dissemination Coordinator

Ms Louisa Marie Shakou

European University Cyprus

e: l.shakou@research.euc.ac.cy
p: +357 22 559513

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