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

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And EU-CIRCLE project team

EU-CIRCLE Data

- Call: H2020-drs-2014: "Disaster-resilience: Safeguarding And Securing Society, Including Adapting To Climate Change"

- **<u>Topic: Disaster Resilience & Climate Change topic 1</u>**:

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

- Grant Agreement: 653824
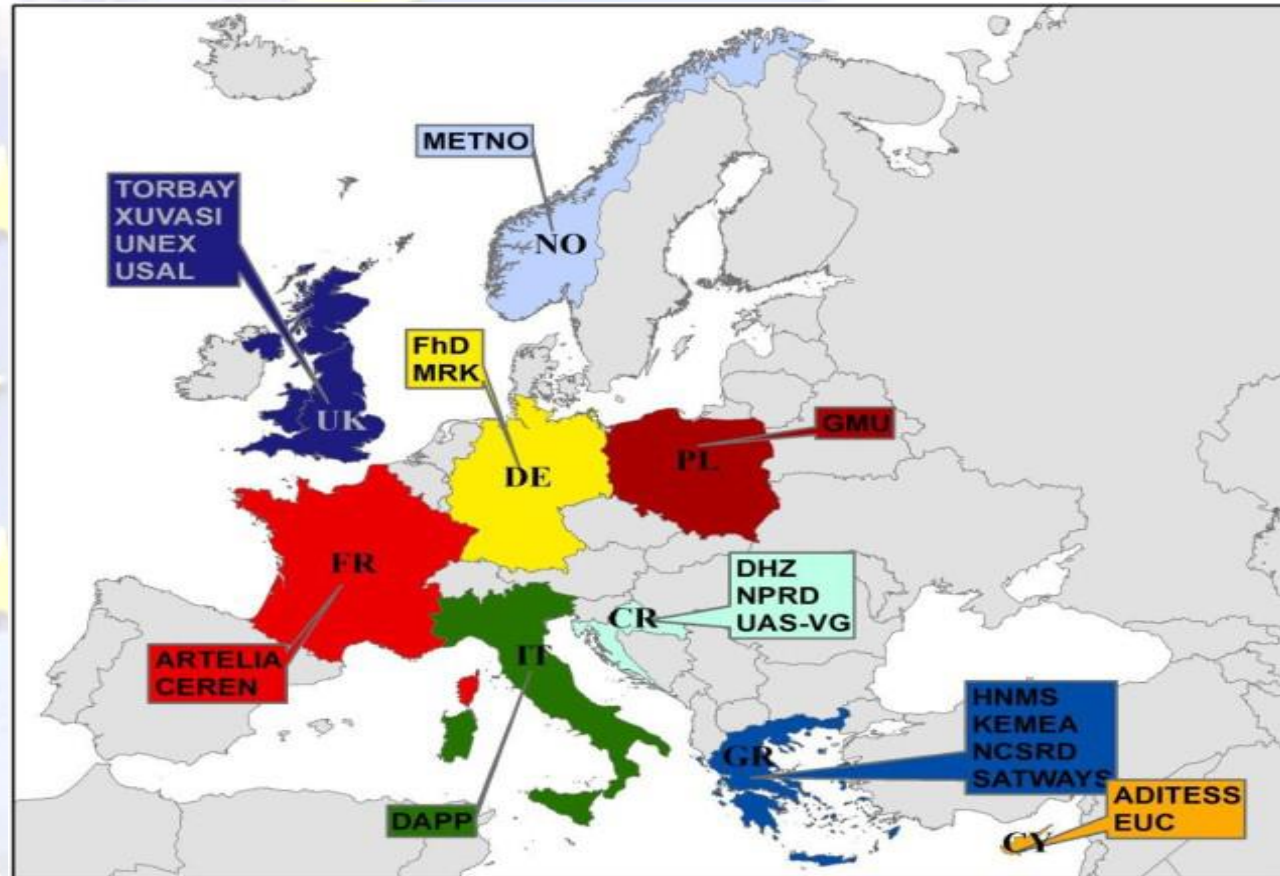
- Total Budget: 7,283,525.00 €

EU-CIRCLE Consortium

20 partners

9 EU countries

13 International members of Stakeholder's Advisory Group

EU-CIRCLE Main Scope

EU-CIRCLE's scope: to derive an innovative framework for supporting the _**interconnected European Infrastructure's resilience to climate pressures**_.

Development of a validated Climate Infrastructure Resilience Platform **(CIRP)** that will:
- ✓ assess potential impacts due to climate hazards,
- ✓ provide monitoring through new resilience indicators and
- ✓ support cost-efficient adaptation measures.

Addressing community requirements, either in responding to **short-term hazards and extreme weather** events or in **deriving the most effective long term adaptation measures**.

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Related Policies

- **<u>The EU Strategy on Climate adaptation, as identified in *COM (2013) 216 - An EU Strategy on adaptation to climate change,*</u>**

- **<u>National Risk Assessment Plans</u>**
  - COMMISSION STAFF WORKING PAPER on Risk Assessment and Mapping Guidelines for Disaster Management, SEC(2010) 1626, Brussels, 21.12.2010.
  - COMMISSION STAFF WORKING DOCUMENT, Overview of natural and man-made disaster risks in the EU, SWD(2014) 134, Brussels, 8.4.2014

- **<u>European Programme for Critical Infrastructure Protection</u>**:
  - DIRECTIVE 2008/114/EC, on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection, 8.12.2008
  - COMMISSION STAFF WORKING DOCUMENT, on the review of the European Programme for Critical Infrastructure Protection (EPCIP), SWD(2012) 190, Brussels, 22.6.2012
  - COMMISSION STAFF WORKING DOCUMENT on a new approach to the European Programme for Critical Infrastructure Protection Making European Critical Infrastructures more secure, SWD(2013) 318, Brussels, 28.8.2013

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The Time Scales Involved

CI are large scale projects,
that will service the
community for very long time frames.

- Climate change is expected to impact the security / safety critical levels of the infrastructure
- Expose new vulnerabilities due to ageing, changes in the climate patterns, land use…
- Impact the type and characteristics of the interconnections between infrastructures
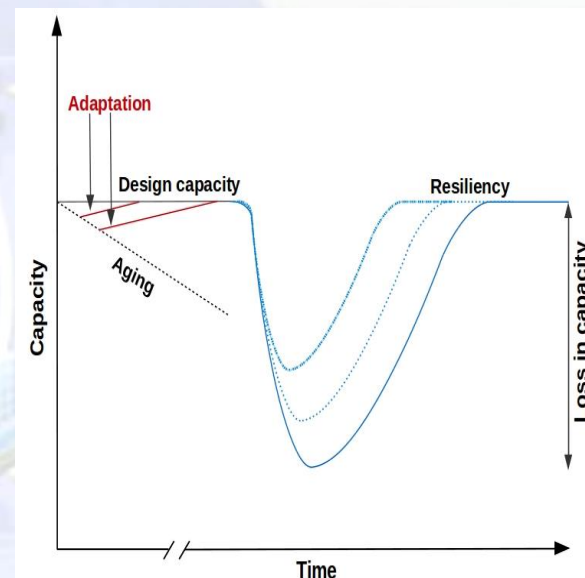
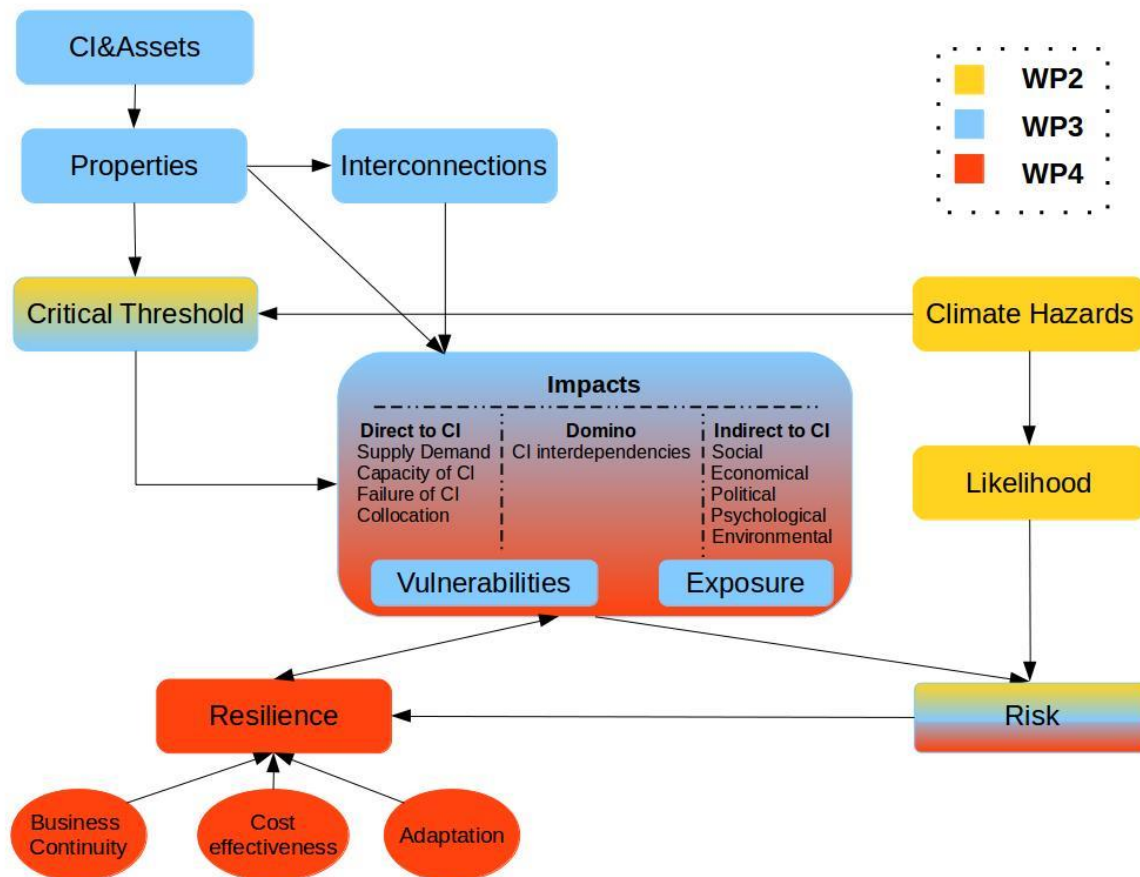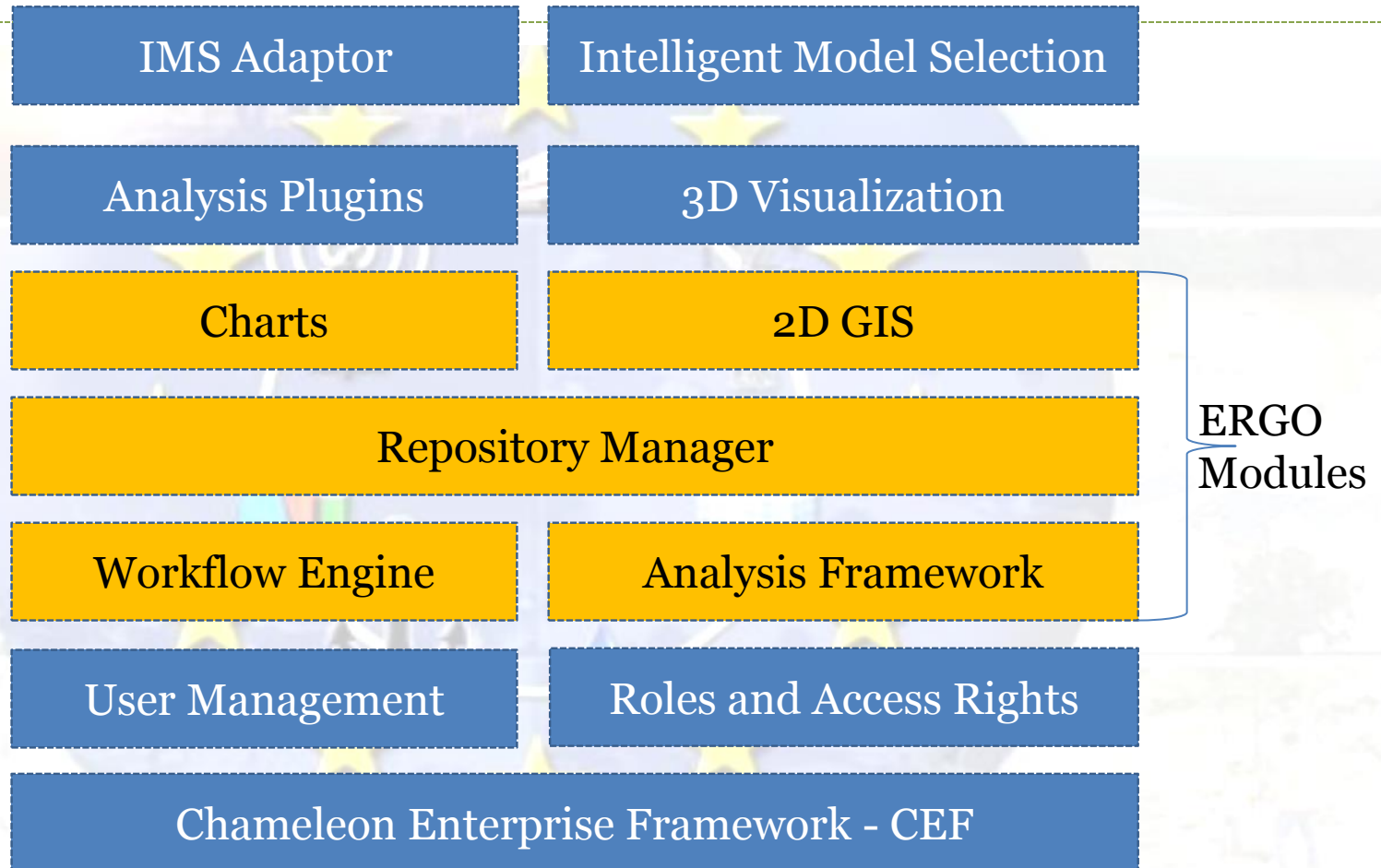# The link: climate related critical thresholds
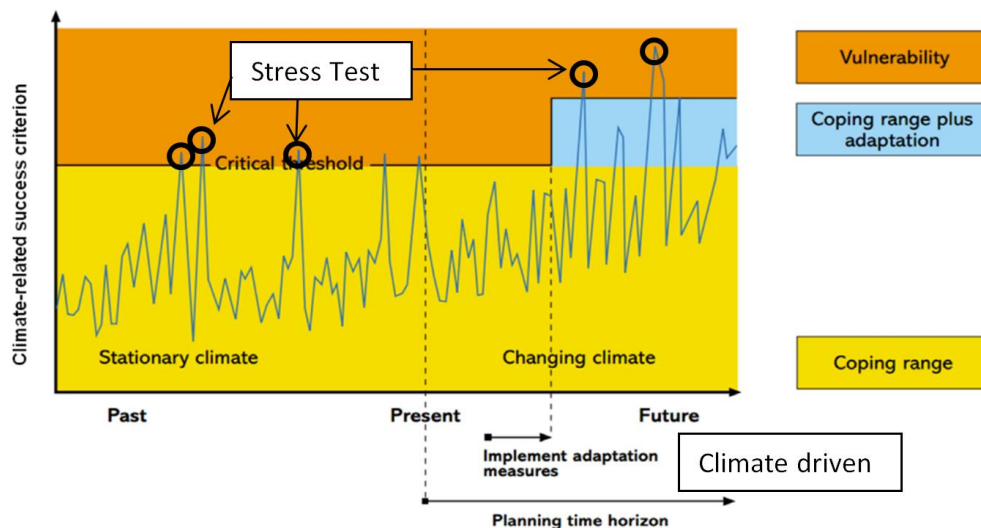
- Two pathways
  - "Stress – test" as the driver. Use CIRP to determine the impacts to the CI Networks (based on critical thresholds) , and link them to climate data – return periods
  - "using climate" as the driver. From climate data obtain the thresholds for a specific analysis / assessment and then feed them to CIRP and obtain output.
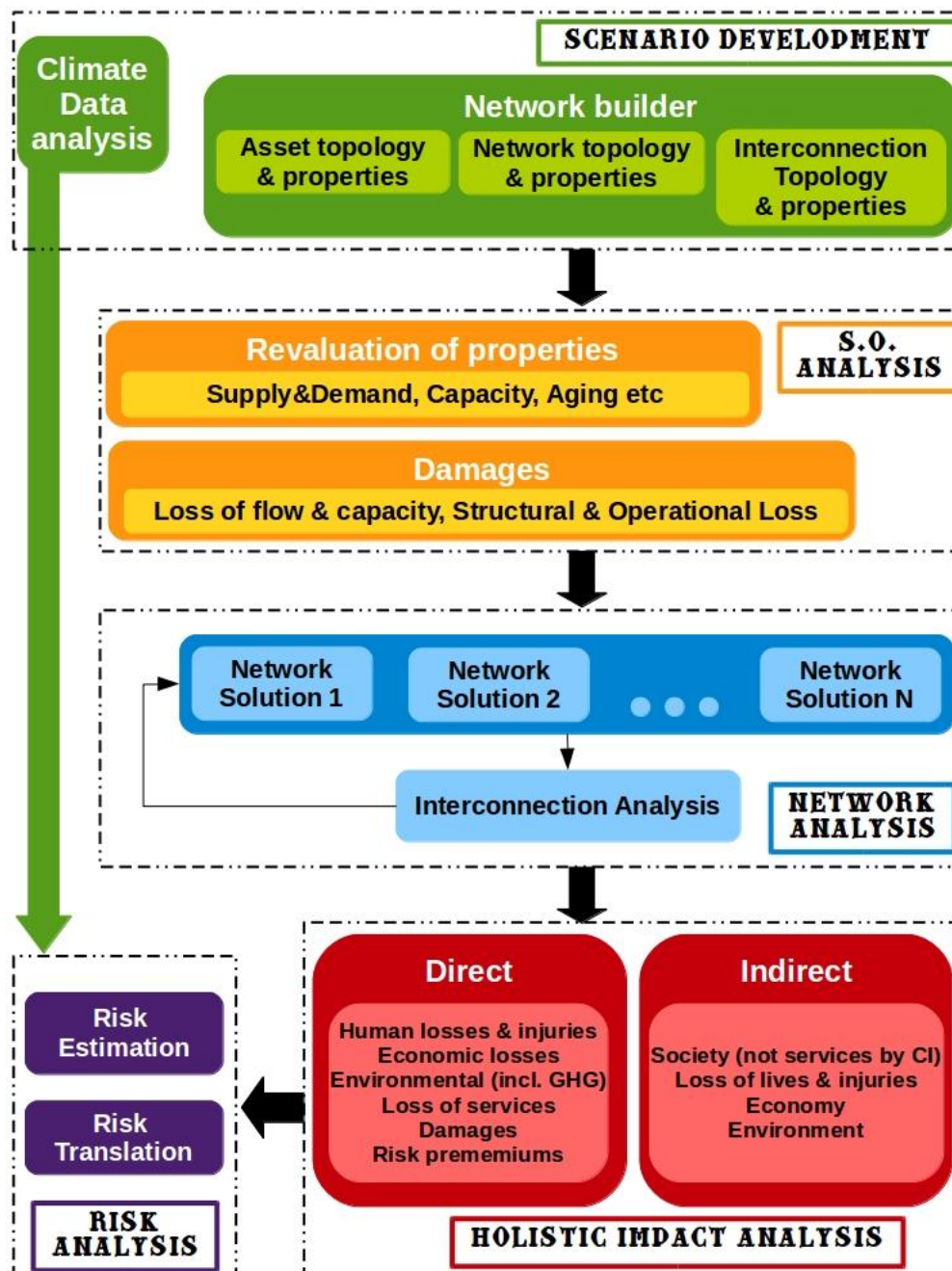
http://www.eu-circle.eu

EU-CIRCLE generic concept

CIRP – Logical Architecture

IMS Adaptor	Intelligent Model Selection
Analysis Plugins	3D Visualization
Charts	2D GIS
Repository Manager	
Workflow Engine	Analysis Framework
User Management	Roles and Access Rights
Chameleon Enterprise Framework - CEF	

ERGO Modules

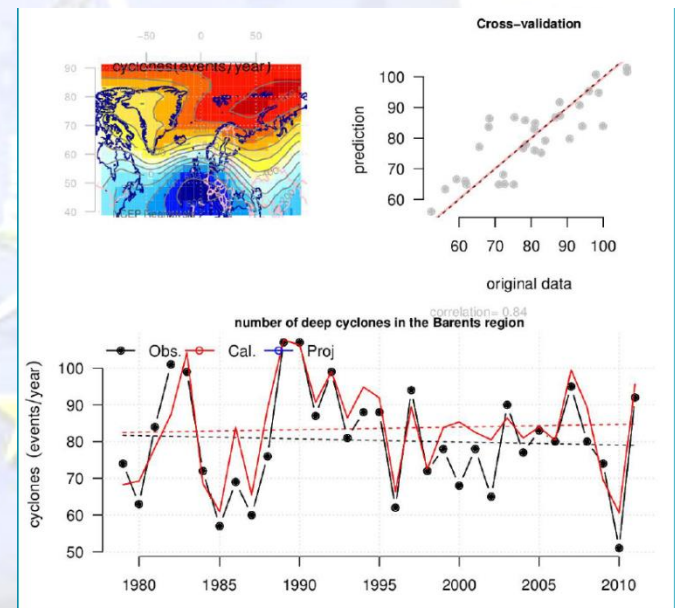# What policy objectives should EU-CIRCLE address? – Scenario Development

- How will a {surface transportation,...} network will respond to extreme events
- How resilient is the {energy, ...} networks to a specific climate hazard (CH)
- What is the risk of a specific CH to the CI sector / network / region
- Which is the optimal adaptation measure for CI, and is this also beneficial for other CH
- How to reduce the domino effects to transportation from electricity network
- Cost benefit analysis (comparison) of different adaptation alternatives
- Addressing the aging of infrastructures,
- What is the economic / societal impacts of resilience

Climate Data

- Any type of data may be used
  - Regional – local scale

  - Any temporal resolution

  - Model
  - Observational

  - Secondary hazards
    - Forest fires, flooding, …

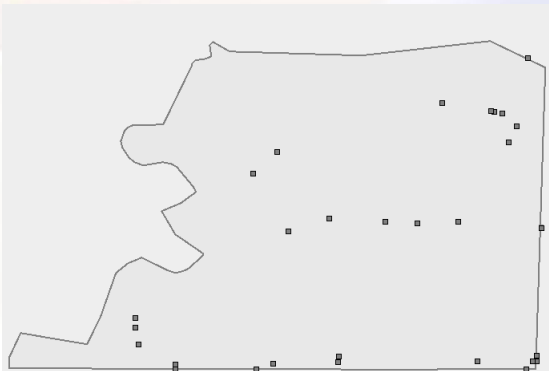| Event	Probability of Occurrence in any given year	Cumulative probability in 100 years	Cumulative probability in 200 years
10 Year Flood	10%	100%	100%
50 Year Flood	2%	87%	98%
100 Year Flood	1%	63%	87%
500 Year Flood	0.2%	18%	33%

Network builder

Figure 1: Energy installations
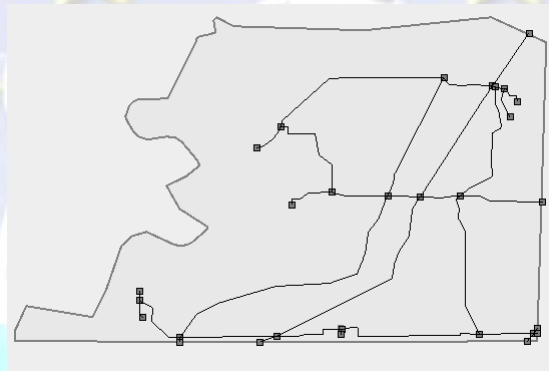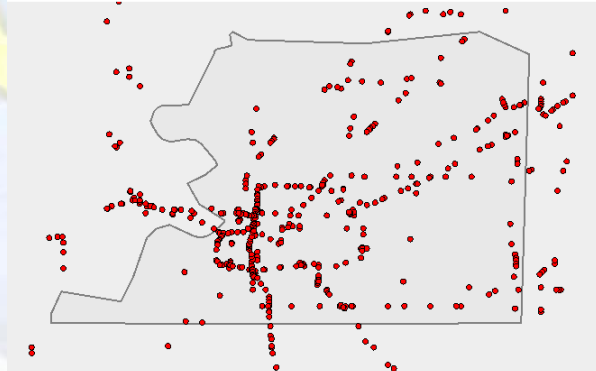

Figure 2: Pipelines

Figure 3: Main Highways

Figure 4: Bridges
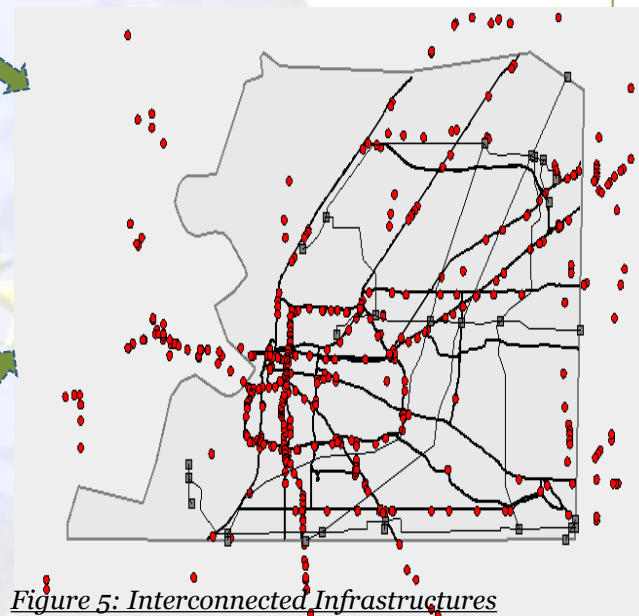

Figure 5: Interconnected Infrastructures

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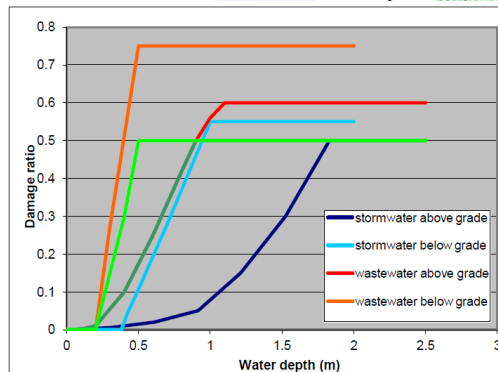
Structural & Operational Analysis
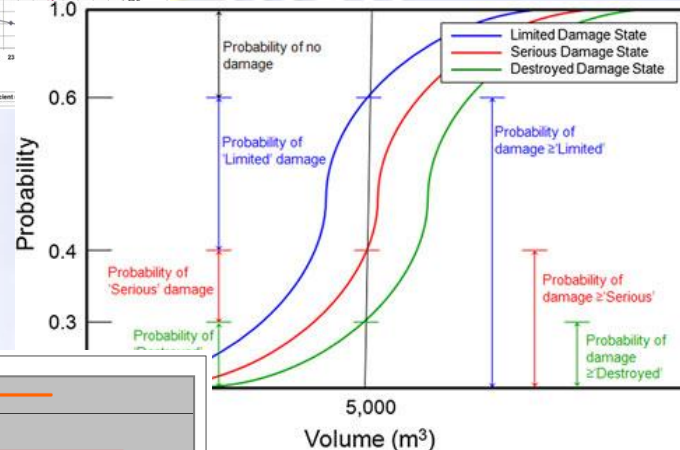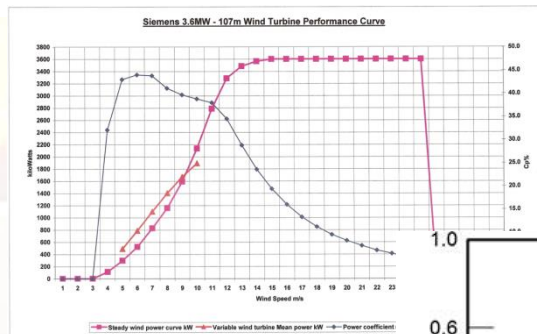
Figure 9: Flood fragility functions for water transportation pump stations

|	TRANSPORTATION			
	MARITIME	**ROAD**	**RAILWAY**	**AVIATION**
# of days with Tmax(heat stress): Tmax≥ 32 ⁰C, Cold waves: Tmean≤ 0 ⁰C, Tmean≤ - 7 ⁰C, Daily mean(TG), maximum (TX), minimum(TX)	*Heat stess: overheating and fatigue, hazardous for certain groups of workers cold waves: freezing sea and structures*	*Heat stress: Reduced safety for vehicles driving, Railroad track deformities, instability of road substructure, melting asphalt and rutting, roadside fires, road asphalt cracking, problems on steel bridges, buckling risk, reduced safety for vehicles driving, fatigue among drivers, Cold waves: fatigue, Damage to roadway integrity*	*rail buckling risk Disturbance to transport electronic infrastructures, signaling, shortened life expectancy of rail, increase wildfires can damage infrastructure*	*change in required airport runway length, decrease airport lift*
Extreme precipitation - floods: # of days R≥30-50mm/day, 100mm/day, Total daily precipitation	*flooding, thunderrstorms, electricity breakdown at port, reduced visibility, degradation of wharves through increased corrosion*	*evacuation flooded roads/tunnels, bridges exposed to 20%-40% increase in 100-yr river discharge, reduced safety for vehicles driving*	*flooding of underground transist systems, ushflow avalanches, trees and branches, landslides and associated risks,destabilization of embankment*	*reduced safety, flood damage to runways an and to other infrastructure*
Landslides (R≥ 150-200 mm/24h)		*landslides, lushflow avalanches, landslides and associated risks, reduced safety for vehicles driving*	*ushflow avalanches, landslides and associated risks*	
Snowfall Rs ≥ 1 cm/d, Rs ≥ 10 cm/d, Blizzard: Rs ≥ 10 cm/d, Tmean≤ 0 ⁰C, WG ≥ 17 m/s	*snow cover, high humidity at harbour*	*reduced visibility, ice on the roads increased propability of incidents, reduced safety for vehicles driving, Damage to roadway integity due to thawing of permafrost, soil instability, ground movement and slope instability*	*increased propability of incidents, soil instability, ground movement and slope instability, Ice on trains and catenary*	*disturbances, delays and cancelations or interruption of operation*
extreme winds, wind gusts(6h): WG ≥ 17 m/s , WG ≥ 25 m/s	*wind effect on ships ' performance and harbour structure, delays to berthing and cargo-handling operations waves, problems on ship navigation, Damage to infrastructure on seaports.*	*trees and branches overturned trucks etc increased noise reduced road speed*	*Disturbance to transport electronic infrastructures, signaling, trees and branches*	*reduced safety, wind damage to terminals, disturbance to transport electronic infrastructures, signaling, etc*
Sea level rise, sea storm	*flooding, erosion of coastal structures, affection of chemical structure of buildings, and structural fatigue, Degradation of wharves through increased corrosion*	*floods, coastal infrastructure at risk of inundation, erosion of coastal structures, buckling risk, reduced safety for vehicles driving*	*bridge washouts, underpass and basement flooding, disturbance to transport electronic infrastructures, signaling, erosion of coastal structures*	*Some low lying airports could also be temporarily or permanently inundated transport and sea ports infrastructures progressively unavailable without adaptive retrofitting measures*
R. Molarius,, Nat Hazards May 2014, 72(1) Melissa Nursey-Bray , Journal of Environmental Planning and Management, 56:7, 1021-1045 McColl, L., Defra Project Code GA0204, UK, Jan 2012 Françoise N., JRC, 2012	L. A. Bollinger, Regional Environmental Change 14(3), pp 919-931 R. Molarius, Nat Hazards, 2014, 72(1), pp 189-210 Vadja A., Nat Hazards(2014) 72:169-188 Françoise N., , JRC, 2012 Thornes, J., UK 2012 S. C. Pryor, Climatic Change (2013) 121:79–91; M. Kangas, HIRLAM Newsletter no. 51, October 2006, John MacArthur, OTREC-RR-12-01, January 2012, Melillo, e, Eds., 2014, U.S. Global Change Research Program, 841 pp. *http://www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/re ports/03088/05.cfm Adapting infrastructure to climate change, SWD(2013)137.			

Network simulation
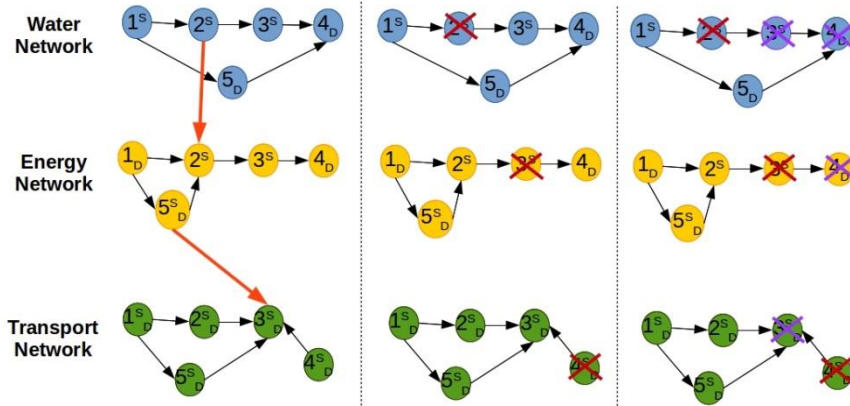
Interdependency Network Analysis
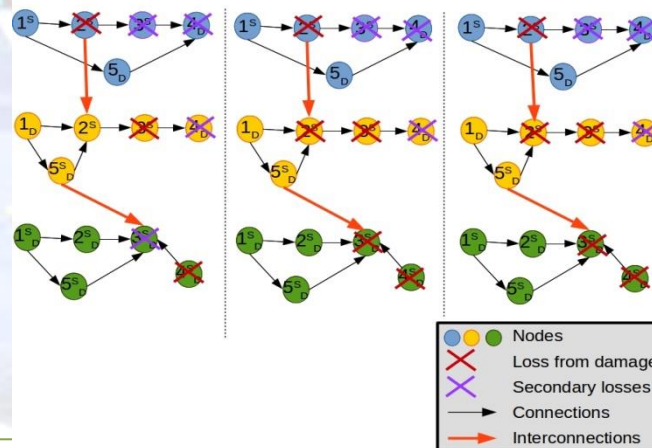
Network Solution
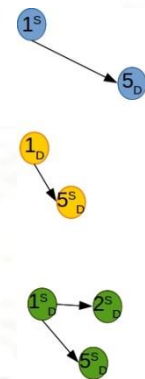
Impact Analysis

- Direct to infrastructures   Indirect (Society)

And their networks
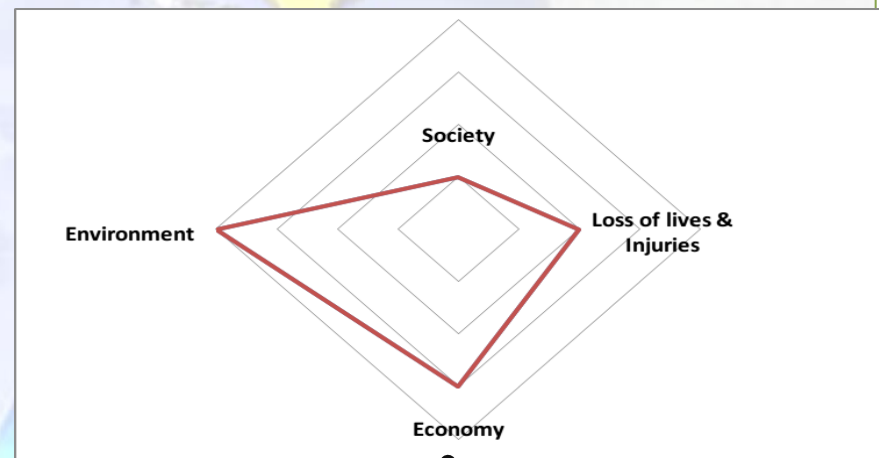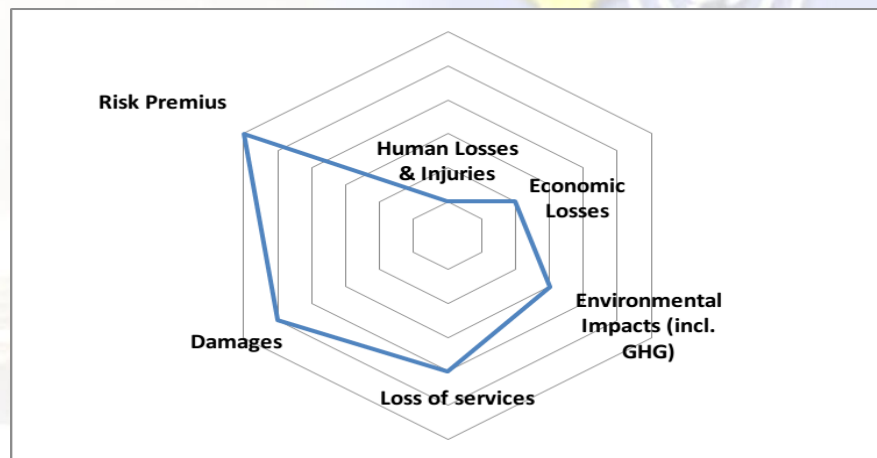
Holistic Impact Analysis
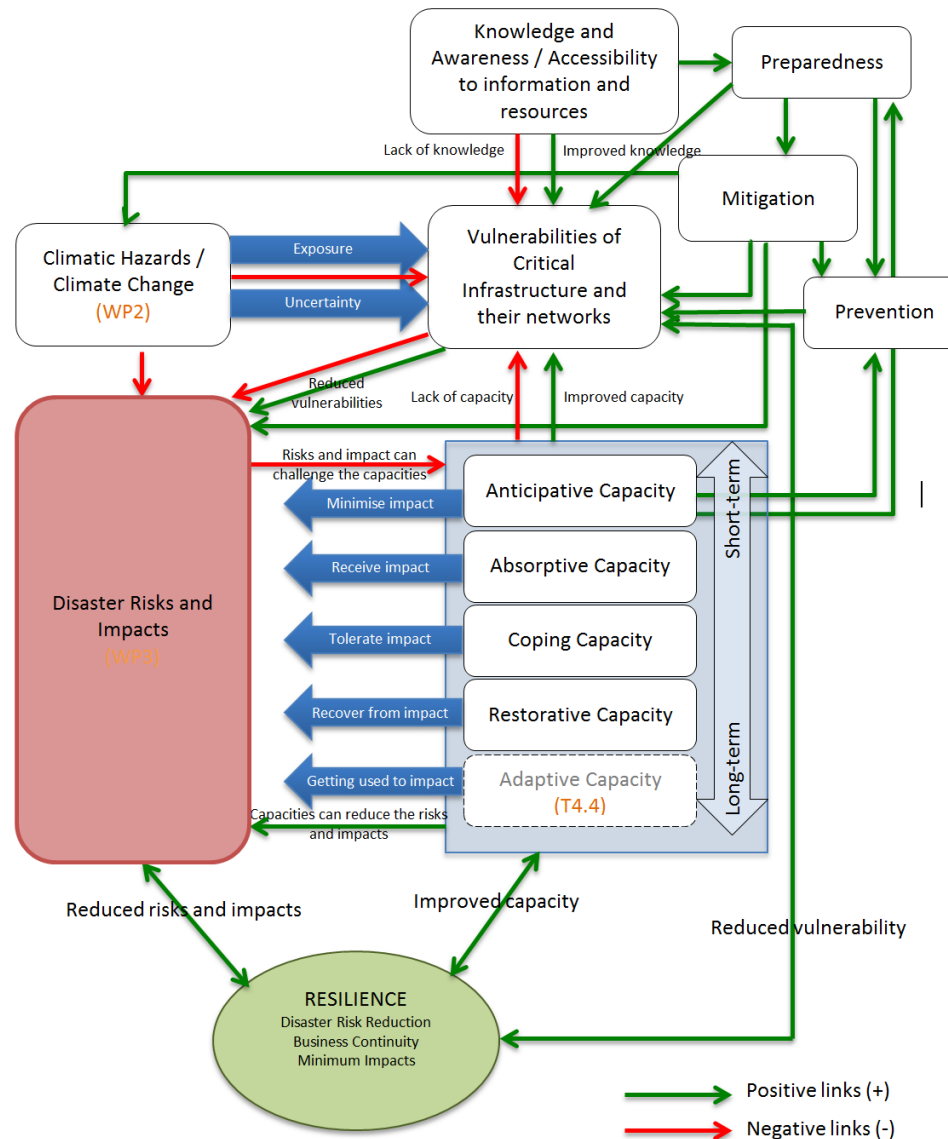
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Risk Assessment

- **Bridge the gap** between the climate change, natural hazards (Civil Protection) and the infrastructure protection community

- Support
  - Probabilistic
  - Categorical

Likelihood ↑					
Very likely/Certainly, e.g. Once every few years					**Critical**
				High	
likely			**Medium**		
		Low			
Unlikely, e.g.: Less frequent then in 100 years	**Very low**				
	Minor, e.g. few simple injured, few non critical damages at buildings		Moderate		Major, e.g. mass casualty incident, collapse of structures , loss of cultural heritage
	Impact →				

- Provide a translation

Effective linkage between different communities

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Resilience

EU-CIRCLE Impact

✓Support the establishment of climate resilient infrastructure by ensuring that an asset is located, designed, built and operated with both the current and future climate in mind and incorporates resilience to the impacts of climate change over the lifetime of that asset.

✓ Provide a coherent baseline for moving from sector-based climate resilience infrastructure frameworks, into holistic resilience plans for entire regions, introducing the interdependencies of heterogeneous infrastructures in the implementation process.
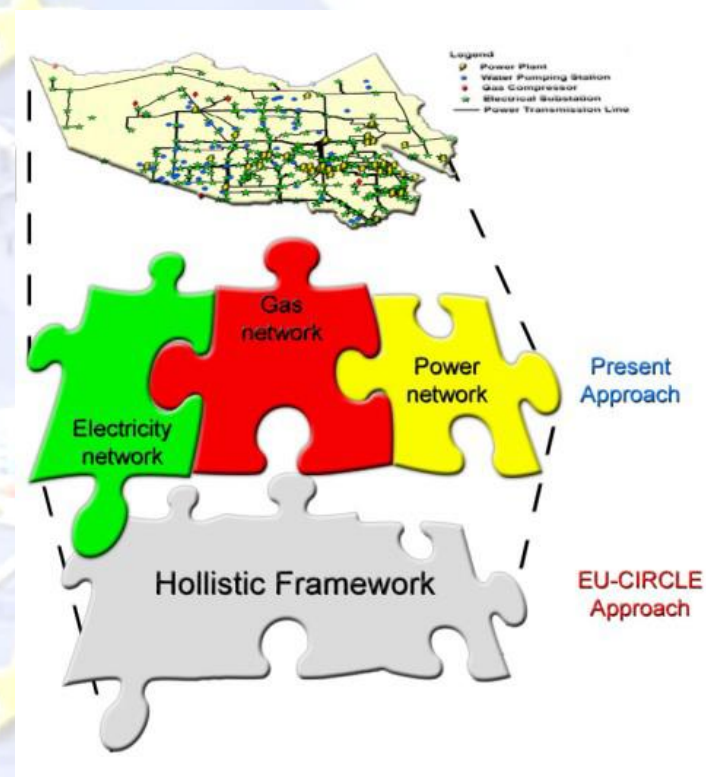
EU-CIRCLE Validation

Case Study 1: Extreme Dryness and forest fires on electricity and transport networks
Lead Partner: ENTENTE POUR LA FORÊT MÉDITERRANÉENNE

Case Study 2: Storm and Sea Surge at a Baltic Sea Port , Gdynia Poland
Lead Partner: AKADEMIA MORSKA W GDYNI

**Case Study 3**: Coastal Flooding (surface water, highway, sewer and watercourse flooding) across Torbay, UK
Lead Partner: UNEXE and Torbay Council

Case Study 4: International Event
Lead Partner: USAL and NCSRD

Case Study 5: Rapid Winter Flooding (melting ice, narrow mountain streams, flooding) around Dresden, Germany
Lead Partner: Fraunhofer IVI

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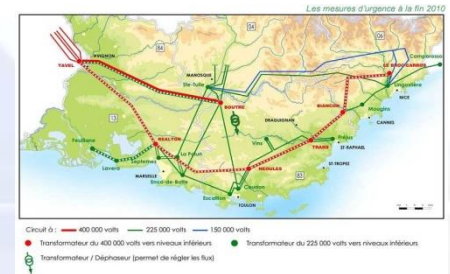
EU-CIRCLE Open Participation

Access to the CIRP and SimICI will be facilitated to non-consortium members.

Approximately, one year before the Final Workshop, there will be an announcement through the EU-CIRCLE project website, through the national NCP and related scientific societies with an open invitation to participate in the final demonstration.

During period of expression of interest until the actual event, there will be continuous support from the consortium members for external partners on how to optimally integrate their tool into the EU-CIRCLE solution.
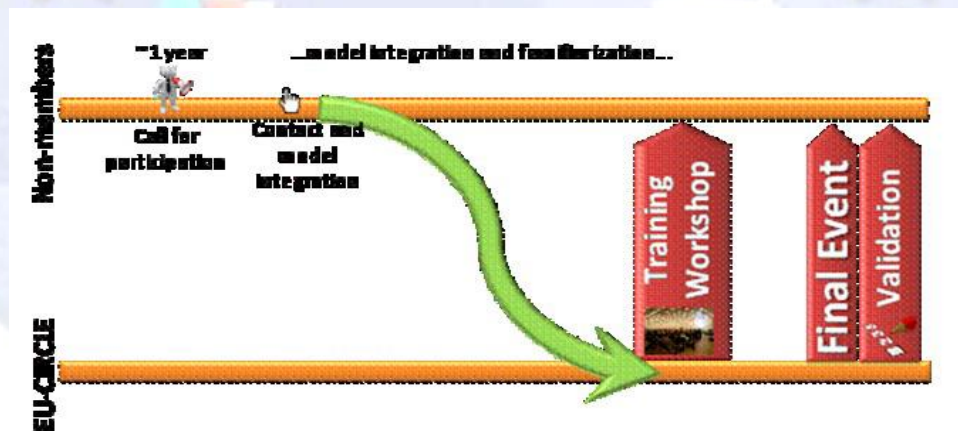
Thank You For Your Attention

http://www.eu-circle.eu