Climate resilience proofing for infrastructure projects – Roads

18 April 2024

Marian Purtz

European Investment Bank

Jaspers

European Commission

Jaspers

Overall Context…

EU climate objectives & funding requirements

- EU climate objectives aim to ensure climate resilience
- CC VRA a requirement for Major Projects in 2014-2020 & further enhanced in Climate Change Proofing for adaptation in 2021-2027

The Green Deal


EUROPEAN COMMISSION

Commission Notice

EN EN

[Technical guidance on the climate proofing of infrastructure 2021-2027](#)

Climate hazards impacting infrastructure

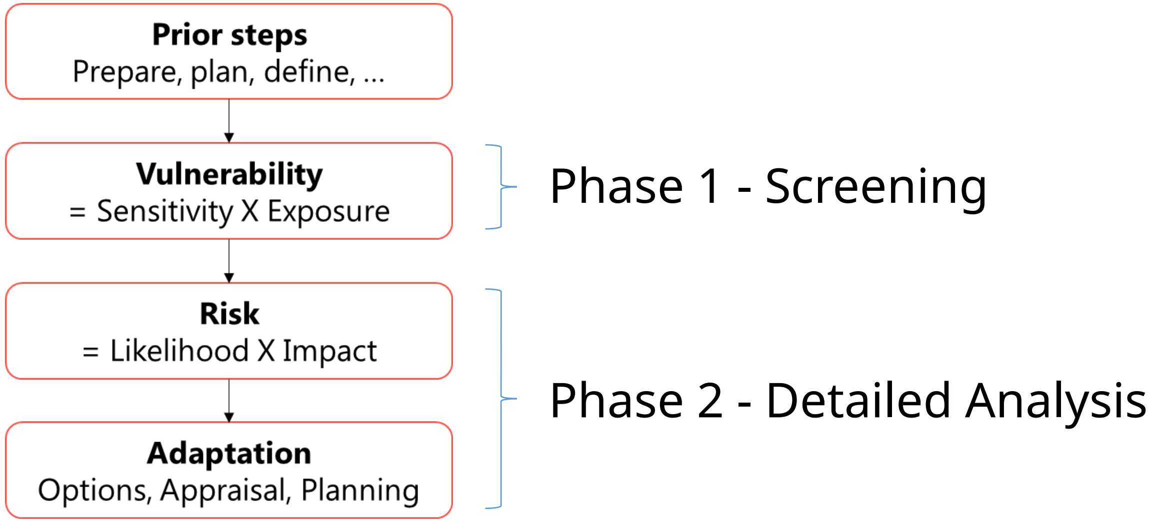
Climate change impacts and adaptation in Europe. JRC PESETA IV, 2020

"Within the EU, losses from extreme weather events ***already average over EUR 12 billion per year****"*

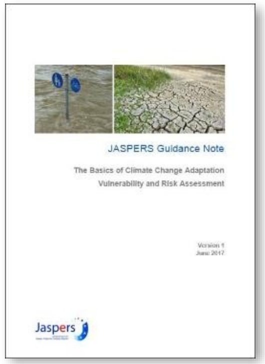
Climate Change Vulnerability & Risk Assessment (CCVRA)

- CC VRA as a basis for Climate Change Proofing for adaptation pillar for EU co-financing in 2021-2027 (as in 2014-2020):
  - Identify which climate hazards the project is vulnerable to, assess the level of risk and integrate adaptation measures to reduce that risk to an acceptable level
  - Cover current climate variability and future climate change

- Climate Risk Assessment (CRA) is also a key tool for assessing climate resilience of EIB/ IFIs operations.



EU 2014-2020

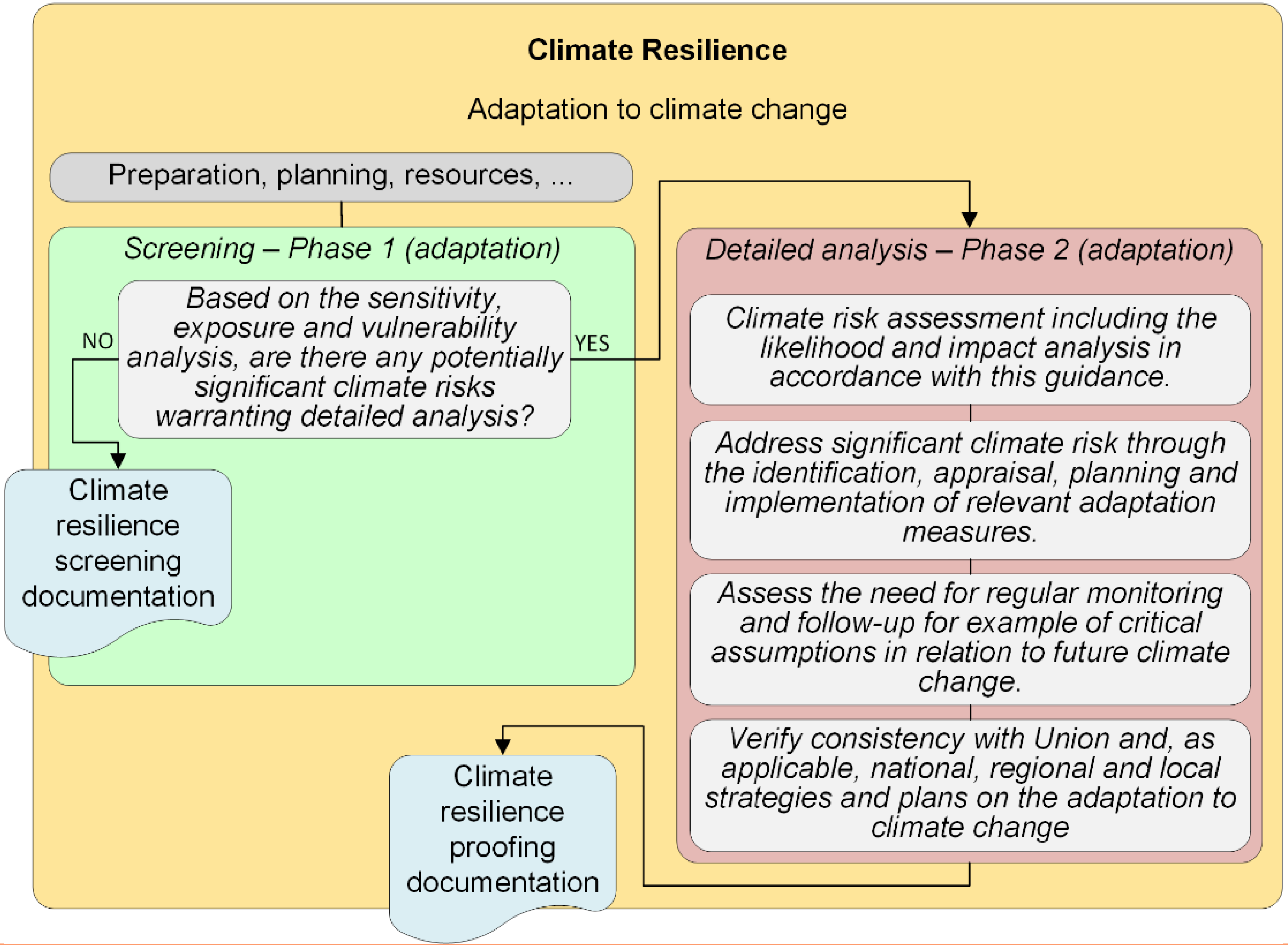


- Climate change and major projects
- JASPERS Guidance – The Basics of Climate Change Adaptation Vulnerability and Risk Assessment

EU 2021-2027

- Technical guidance on the climate proofing of infrastructure 2021-2027

Climate Resilience Proofing (Climate Change Adaptation)



Case Study – Road Project

Some considerations:

- Main objective: **undertaking Climate Resilience Proofing** on a specific project
  - Identifying climate risks and define relevant adaptation measures
- Providing some **practical insight** on implementing CCVRA as a tool for climate resilience in projects development cycle
  - The case study provides sectoral specific insight, but principles might be of general relevance
- It is **an example and not a unique model** to follow
  - Methodological framework, assessment principles, scoring levels… to be tailored to the project specificities, key is to demonstrate clear and logical thinking
  - Assessment results presented referred to the specific case study (Project)!

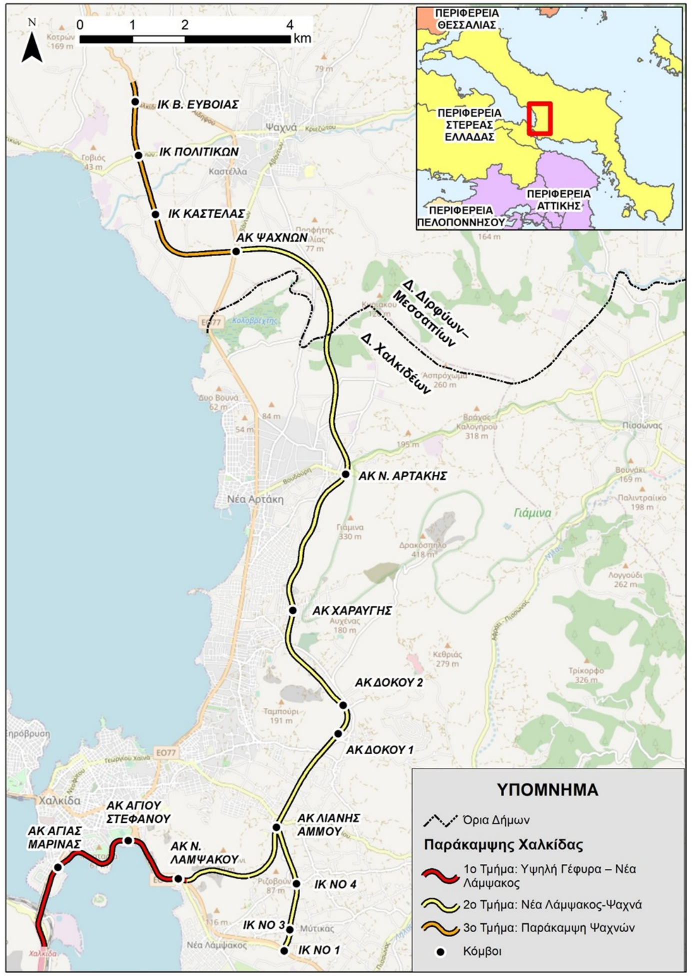
Case Study – Highway Bypass Project

Project objectives:

- improve traffic and safety conditions on TEN-T comprehensive
- facilitate long distance and regional traffic
- improve transport accessibility and interregional connections to TEN-T network
- with a climate resilient road section.

Project scope:

- approx. 26 km long bypass with 2x2 and 2x1 sections
- TEN-T comprehensive network, Evoia Island, Central Greece
- running mainly through semi-rural and agricultural land, meadows, but also crossing some semi-urban areas
- AADT (2028)=9,000 – 32,000 veh/day, AADT (2052)=13,000-44,000 veh/day



Note:

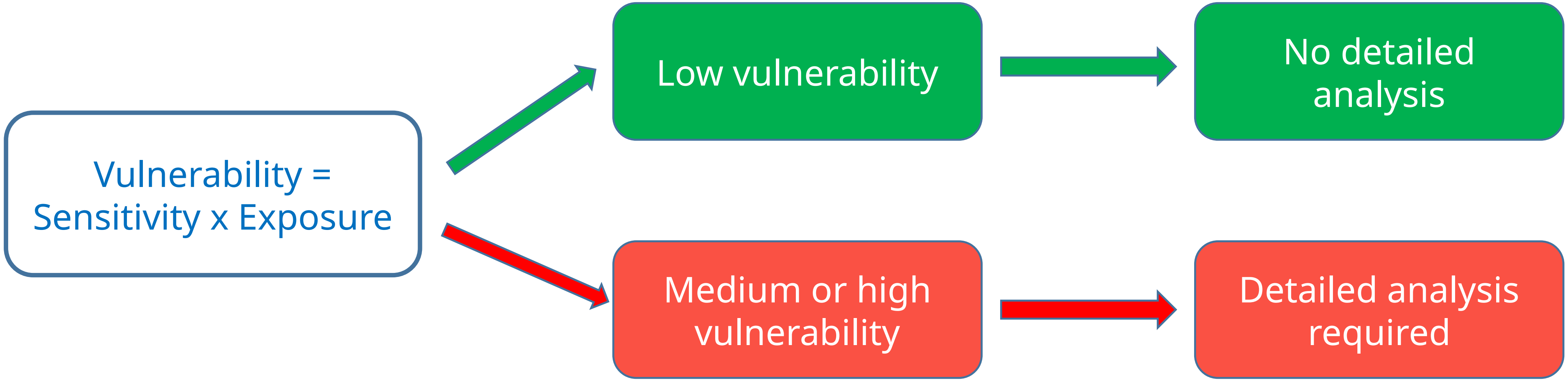
The early preparatory phases of the project are advanced, the project construction design is to be performed.

Climate Resilience – Screening (Phase I)

Aim: Identify the vulnerabilities of the project to climate change

Vulnerability assessment:

- **Sensitivity analysis -** how sensitive is the investment to climate hazards based on the **type of project** (irrespective of the location)
- **Exposure analysis -** which hazards are expected to be present at the **investment location** now and in the future (irrespective of the project type)



"Screening" for risks – focuses the risk assessment to use resources effectively

Vulnerability analysis

Sensitivity analysis – how do climate hazards impact a road project?






Climate Hazards considered

Climate Hazard
Heatwave
Forest fire
Cyclone, Strong Storms, Hurricane
Strong precipitation (rain, hail, snow/ice)
Flooding (coastal areas, rivers, rain, groundwater)
Landslide/Soil erosion
Precipitation
Thermal stress
Sea level rise
Coastal erosion
Heatwave
Forest fire

See for reference:
List of climate hazards according to the EU Taxonomy Climate Delegated Act

The basics of climate change adaptation, vulnerability and risk assessment, JASPERS

Vulnerability analysis

Sensitivity analysis

How do climate hazards impact a road project (irrespective of its location)?

- Construction
- Operation
- Products/ services
- Functionality within the area

Vulnerability = Sensitivity x Exposure

Scoring principles

Level		Description
0	*No / Negligible Sensitivity*	No infrastructure service disruption or damage – business as usual
1	*Low Sensitivity*	Localised infrastructure service disruption. No permanent damage, some minor restoration work required
2	*Medium Sensitivity*	Widespread infrastructure damage and service disruption requiring moderate repairs. Partial damage to local infrastructure
3	*High Sensitivity*	Permanent or extensive damage requiring extensive repair

Clear Assessment and Scoring principles

Vulnerability analysis

Sensitivity analysis results

Vulnerability analysis for the project:		Bypass of Chalkis				
Group	Source of Risk	Sensitivity: Construction	Operation	Products Services	Integration in the region	Total Sensitivity
Acute hazards	Heatwave	Moderate	Moderate	Low	Low	**Moderate**
	Cold wave	Low	Moderate	Low	Low	**Moderate**
	Frost (Number of days with AI <0)	Low	Moderate	Low	Low	**Moderate**
	Forest fire	Moderate	Moderate	Moderate	Moderate	**Moderate**
	Cyclone, Strong Storms, Hurricane	Moderate	Low	Low	Low	**Moderate**
	Storms (including snowstorms, dust storms)	Low	Moderate	Moderate	Low	**Moderate**
	Tornado/Winter Winds	Moderate	Moderate	Low	Low	**Moderate**
	Drought	Low	Low	Low	Low	**Low**
	Strong precipitation (rain, hail, snow/ice)	Moderate	Moderate	Moderate	Low	**Moderate**
	Flooding (coastal areas, rivers, rain, groundwater)	High	High	Moderate	Low	**High**
	Landslide/Soil Corrosion [1]	High	High	Low	Moderate	**High**
	Precipitation	Moderate	Moderate	Moderate	Low	**Moderate**
ks	Variation in meanair purification	Low	Low	Low	Low	**Low**
	Urban Thermal Islet	Low	Low	Low	Low	**Low**
	Thermal stress	Low	Moderate	Low	Low	**Moderate**
	Temperature variability	Low	Low	Low	Low	**Low**
	Change in solar radiation	Low	Low	Low	Low	**Low**
	Change in characteristics of					

Vulnerability analysis

Assessing Current & Future Exposure

- Use available climate projection tools sources e.g.:
  - Web-based climate projection tools for Greece developed under the LIFE-IP AdaptInGR project used (www.adaptivegreece.gr)
  - Geospatial Information Portal of the Ministry of Interior (https://mapsportal.ypen.gr/thema_climatechange)
  - National Hub for Adaptation to Climate Change (https://geo.adaptivegreecehub.gr)

- Use available national and regional studies, strategies and plans as a basis for exposure assessment
  - Regional Climate Change Adaptation Plan (PESPA) for the Region of Central Greece (Περιφερειακό Σχέδιο Προσαρμογής στην Κλιματική Αλλαγή (ΠεΣΠΚΑ) για την Περιφέρεια Στερεάς Ελλάδας - Περιφέρεια Στερεάς Ελλάδας (pste.gov.gr))

- But do not underestimate available recent meteorological data, local knowledge and evidence of recent climate incidents in the project area!

Vulnerability =
Sensitivity x Exposure

Vulnerability analysis

Assessing Current & Future Exposure at regional level

Parameters considered within the PESPA for the Region of Central Greece:

- Average daily air temperature at 2 m (^{o}C)
- Average daily relative humidity of air (%)
- Average daily cloud fraction (%)
- Average duration of sunshine (hours/day)
- Average daily wind speed at 10 m (m/s)
- Total daily precipitation (mm/day)
- Total daily precipitation

Περιφερειακό Σχέδιο Προσαρμογής στην Κλιματική Αλλαγή (ΠεΣΠΚΑ) για την Περιφέρεια Στερεάς Ελλάδας

1 Φεβρουαρίου 2021 / in Ανακοινώσεις

Post Views: 5.269

Κατεβάστε το pdf αρχείο

Στρατηγική Μελέτη Περιβαλλοντικών Επιπτώσεων του Σχεδίου Προσαρμογής στην Κλιματική Αλλαγή Περιφέρειας Στερεάς Ελλάδας (θεωρημένη)

Vulnerability analysis

Assessing Current & Future Exposure

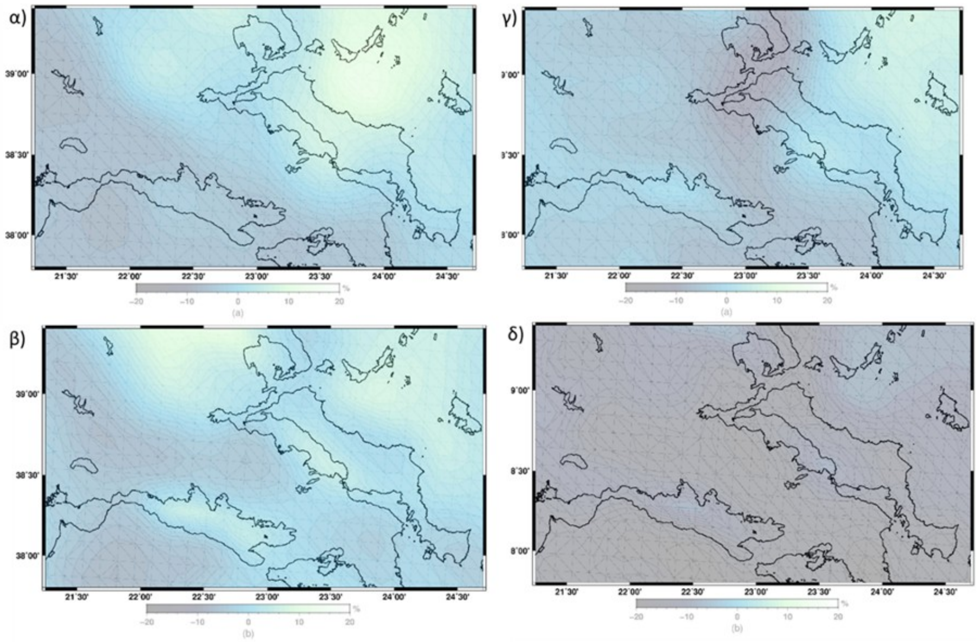


Image 3-2 Percentage changes in average annual precipitation between periods (a) 2021-2050 and 1961-1990, (b) 2071-2100 and 1961-1990 for the RCP4.5. Similar images (c) and (d) for the RCP8.5

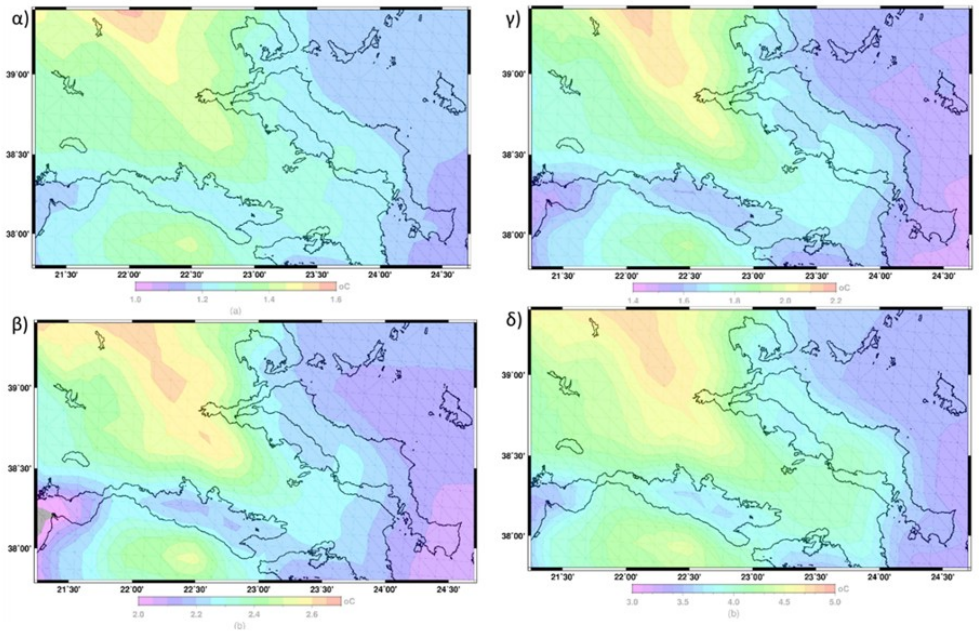


Image 3-1 Changes in average temperature at 2 m (oC) between periods (a) 2021-2050 and 1961-1990, (b) 2071-2100 and 1961-1990 for the RCP4.5. Similar images (c) and (d) for the RCP8.5

Περιφερειακό Σχέδιο Προσαρμογής στην Κλιματική Αλλαγή (ΠεΣΠΚΑ) για την Περιφέρεια Στερεάς Ελλάδας

1 Φεβρουαρίου 2021 / in Ανακοινώσεις

Post Views: 5.269

Κατεβάστε το pdf αρχείο

Στρατηγική Μελέτη Περιβαλλοντικών Επιπτώσεων του Σχεδίου Προσαρμογής στην Κλιματική Αλλαγή Περιφέρειας Στερεάς Ελλάδας (θεωρημένη)

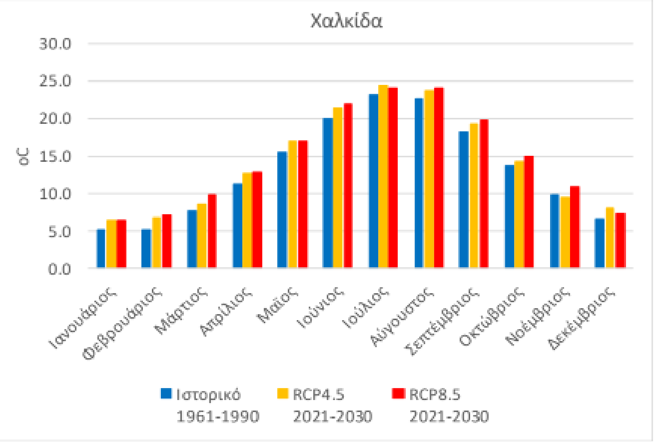
Vulnerability analysis

Assessing Current & Future Exposure

Climate projections for the project area:

- ↑ average annual and summer temperatures
- ↑ number of days with heatwaves
- ↑ number of days with high fire risk
- ↓ number of days with cold spells and snowfall
- ↓ annual precipitation
- ↑ occurrence of extreme precipitation events
- ↑ sea level rise

φφ	1961-1990		2021-2050				2071-2100			
			RCP4.5		RCP8.5		RCP4.5		RCP8.5	
Μέση ετήσια θερμοκρασίας αέρα στα 2 m (°C)										
Βοιωτία	12.43	±0.83	13.72	±0.81	14.21	±0.79	14.76	±0.78	16.55	±0.73
Εύβοια	13.78	±0.88	15.00	±0.85	15.43	±0.81	15.98	±0.83	17.56	±0.71
Ευρυτανία	7.56	±0.85	8.92	±0.85	9.40	±0.84	10.01	±0.83	11.93	±0.81
Φθιώτιδα	10.56	±1.80	11.96	±1.78	12.52	±1.77	13.08	±1.75	15.04	±1.67
Φωκίδα	9.32	±2.32	10.66	±2.28	11.13	±2.25	11.74	±2.22	13.61	±2.12
Συνολική ετήσια κατακρήμνιση (mm)										
Βοιωτία	611.1	±127.4	600.2	±125.1	576.0	±115.2	601.8	±115.3	512.8	±102.2
Εύβοια	657.2	±148.7	680.2	±164.1	644.0	±145.3	658.9	±144.9	565.5	±126.1
Ευρυτανία	1160.5	±169.7	1092.9	±143.7	1119.9	±163.1	1101.5	±145.9	1005.2	±146.5
Φθιώτιδα	745.7	±138.1	750.6	±127.4	700.5	±129.1	746.0	±116.7	634.9	±108.2
Φωκίδα	938.0	±231.7	891.2	±220.0	898.7	±214.9	898.6	±207.3	798.2	±186.4
Συνολική ετήσια χιονόπτωση (mm)										
Βοιωτία	65.6	±42.7	48.2	±27.6	41.2	±21.8	32.3	±21.1	15.8	±11.9
Εύβοια	51.3	±31.8	44.8	±30.0	36.3	±23.3	29.0	±17.2	15.6	±11.1
Ευρυτανία	287.2	±83.4	210.9	±68.5	185.6	±59.5	162.7	±57.8	94.7	±36.1
Φθιώτιδα	182.2	±81.9	141.5	±67.3	108.6	±57.8	105.0	±53.2	59.6	±34.4
Φωκίδα	232.7	±149.6	176.4	±120.6	151.4	±101.3	133.1	±91.5	78.5	±57.4
Μέση ετήσια ταχύτητα ανέμου στα 10 m. (m/s)										
Βοιωτία	3.22	±0.33	3.24	±0.33	3.27	±0.34	3.21	±0.33	3.24	±0.34
Εύβοια	4.17	±1.28	4.22	±1.31	4.22	±1.30	4.16	±1.29	4.19	±1.32
Ευρυτανία	2.20	±0.12	2.21	±0.11	2.26	±0.10	2.22	±0.10	2.25	±0.08
Φθιώτιδα	2.23	±0.50	2.24	±0.50	2.27	±0.49	2.23	±0.49	2.24	±0.46
Φωκίδα	2.14	±0.52	2.14	±.51	2.19	±0.51	2.15	±0.50	2.17	±0.48



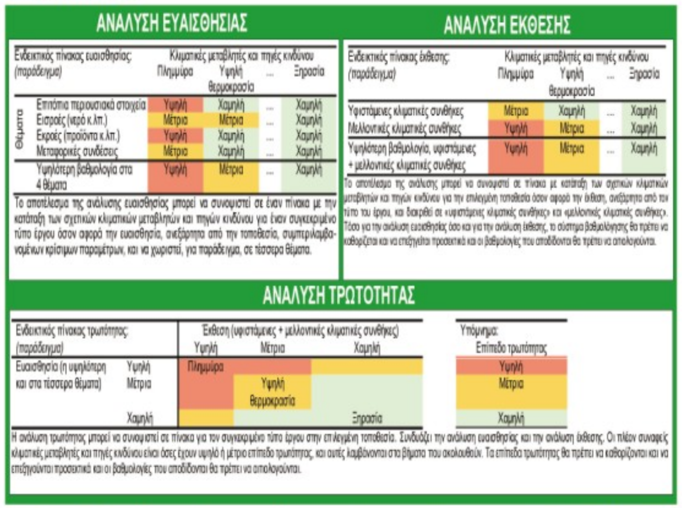
Vulnerability analysis

Project exposure analysis results

Table 3-4 Vulnerability analysis

Group	Vulnerability analysis for the project:	Bypass of Chalkis								
		Sensitivity					Exposure			
Group	Source of Risk	Construction	Operation	Products Services	Integration in the region	Total Sensitivity	Existing conditions	Future conditions	Total Report	Vulnerability
Acute hazards	Heatwave	Moderate	Moderate	Low	Low	Moderate	Moderate	High	High	High
Acute hazards	Cold wave	Low	Moderate	Low	Low	Moderate	Low	Low	Low	Low
Acute hazards	Frost (Number of days with AI <0)	Low	Moderate	Low	Low	Moderate	Low	Low	Low	Low
Acute hazards	Forest fire	Moderate	Moderate	Moderate	Moderate	Moderate	High	High	High	High
Acute hazards	Cyclone, Strong Storms, Hurricane	Moderate	Low	Low	Low	Moderate	Low	Moderate	Moderate	Moderate
Acute hazards	Storms (including snowstorms, dust storms)	Low	Moderate	Moderate	Low	Moderate	Low	Low	Low	Low
Acute hazards	Tornado/Winter Winds	Moderate	Moderate	Low	Low	Moderate	Low	Low	Low	Low
Acute hazards	Drought	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Low
Acute hazards	Strong precipitation (rain, hail, snow/ice)	Moderate	Moderate	Moderate	Low	Moderate	Moderate	High	High	High
Acute hazards	Flooding (coastal areas, rivers, rain, groundwater)	High	High	Moderate	Low	High	High	High	High	High
Acute hazards	Landslide/Soil Corrosion [1]	High	High	Low	Moderate	High	Moderate	Moderate	Moderate	High
Acute hazards	Precipitation	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Moderate
Chronic risks	Variation in meanair purification	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Low
Chronic risks	Urban Thermal Islet	Low	Low	Low	Low	Low	Low	Low	Low	Low
Chronic risks	Thermal stress	Low	Moderate	Low	Low	Moderate	Low	Moderate	Moderate	Moderate
Chronic risks	Temperature variability	Low	Low	Low	Low	Low	Low	Moderate	Moderate	Low
Chronic risks	Change in solar radiation	Low	Low	Low	Low	Low	Low	Low	Low	Low
Chronic risks	Change in characteristics of winds	Low	Low	Low	Low	Low	Low	Low	Low	Low
Chronic risks	Change of characteristics and types of precipitation (rain, hail, snow/ice)	Moderate	Moderate	Low	Low	Moderate	Low	Low	Low	Low
Chronic risks	Precipitation variability or hydrological variability	Moderate	Moderate	Low	Low	Moderate	Low	Low	Low	Low
Chronic risks	Change in average water temperature in water bodies	Low	Low	Low	Low	Low	Low	Low	Low	Low
Chronic risks	Acidification/salinity of sea									

Φάση 1 (προέλεγχος)



Σχήμα 5: Παράδειγμα πίνακα ανάλυσης τρωτότητας σύμφωνα με την Τεχνική Οδηγία

Vulnerability Analysis (Screening – Phase 1)

Resulting vulnerability of the Project

Source of Risk	Vulnerability
Heatwave	High
Forest fire	High
Cyclone, Strong Storms, Hurricane	Moderate
Strong precipitation (rain, hail, snow/ice)	High
Flooding (coastal areas, rivers, rain, groundwater)	High
Landslide/Soil Corrosion	High
Precipitation	Moderate
Thermal stress	Moderate
Sea level rise	High
Coastal erosion	Moderate

Do not be afraid to undertake a risk assessment!

Do not underestimate vulnerabilities!

It is better to identify any potential risk earlier than to witness it later!

Climate Resilience – Detailed analysis (Phase II)

Climate Risk Assessment

- Assessing the **Likelihood (Probability)** of a hazard to occur and the **Severity (Impact)** of the impacts associated with the hazards identified in the vulnerability assessment
- Assessing the **significance of the identified risks and part of overall risk management** for the investment
- Assessment should be **proportionate** to the **scale of the project facilities** and their **expected lifespan**

Risk = Likelihood x Severity of impacts

Risk assessment:

- higher detail than vulnerability assessment
- qualitative and quantified only when possible

RISK ASSESSMENT

Indicative risk table: *(example)*

Overall impact of the essential climate variables and hazards (example)

Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Rare					
Unlikely		Drought			
Moderate		Heat	Flood		
Likely					
Almost certain					

Legend:

Risk level
Low
Medium
High
Extreme

The output of the risk analysis may be summarised in a table combining likelihood and impact of the essential climate variables and hazards. Detailed explanations are required to qualify and substantiate the assessment conclusions. The risk levels should be explained and justified.

Risk Analysis

Assessment and Scoring Principles

Likelihood				Impact on the project (effect)		
Scale	Description	Point value		Scale	Meaning	Point value
Rare	Highly unlikely to occur; 5 %	1		Insignificant	Minimal effect that can be absorbed by ordinary activity	1
Unlikely	Given current practices and procedures, unlikely to occur; 20 %	2		Minor	Adverse event affecting the normal operation of the infrastructure, leading to local impacts	2
Moderate	As likely to occur as not; 50 %	3		Moderate	A serious incident that requires additional management actions and results in moderate effects	3
Likely	Likely to occur; 80 %	4		Major	A critical event requiring extraordinary action, resulting in significant, far-reaching or long-term effects	4
Almost certain	Very likely to occur, possibly several times; 95 %	5		Catastrophic	Catastrophic event that may result in a shutdown or collapse of the component/network, causing significant damage and widespread effects	5

These are just a proposal of scales that need/might be tailored to the specific project

Risk Analysis

Assessment and Scoring Principles

Table 3-8 Risk materiality level assessment matrix

	Probability	Rare	Unlikely	Moderate	Possible	Almost certain
Effects of severity or size		1	2	3	4	5
Negligible	1	1	2	3	4	5
Minor	2	2	4	6	8	10
Moderate	3	3	6	9	12	15
Important	4	4	8	12	16	20
Disastrous	5	5	10	15	20	25

Table 3-9 Inherent (risk) risk scale

Color palette	Level of risk
	Negligible (1 – 3)
	Low (4-6)
	Medium (7-10)
	Important (11 – 19)
	Very important (20 – 25)

Risk Analysis

Likelihood analysis for the Project

For each climate hazard, the likelihood analysis should consider:

- Qualitative or quantitative estimation
- Based on climate hazard projections
- Potential likelihood changes over the lifespan of the infrastructure
- Using past evidence and expert engineering judgment
- Reasons behind choosing the given likelihood levels should be recorded and justified

Risk Analysis

Impact analysis

For each climate hazard, the impact analysis should take into account project location and functionality / criticality of its assets and consider potential impacts on:

- Infrastructure assets and their structural integrity over the entire asset life
- Operational & maintenance aspects
- Health & safety of operators and road users incl. emergency response
- Costs to operators and users (e.g. cost of lost time, increased maintenance / vehicle operating costs, etc.)
- Financial aspects (e.g. loss of profit etc.)
- Wider social and environmental aspects (e.g. access to social and health services, isolation of communities, nearby environmentally sensitive areas affected, etc.)
- Reputational risks (e.g. impact on tourism)
- Any other?

Risk Analysis

Risk Matrix for the case study Project

Risk Level		Likelihood				
		Rare	Unlikely	Moderate	Possible	Almost certain
Impact	Negligible					
	Minor					
	Moderate		Coastal erosion	Average precipitation Sea level rise		Heatwaves Thermal stress
	Important				Forrest fires Extreme precipitation Cyclone/ storms	
	Disastrous			Landslides/ Soil erosion	Flooding	

Risk Analysis

Risk assessment conclusions and adaptation measures

Significant Risks need to be **managed to an acceptable** level through climate adaptation measures including identifying those measures/aspects that are planned as project's in-built resilience.

- Different options for adaptation might be considered
- Such measures can be structural or non-structural (operational and maintenance measures)
- The measures must be integrated into the project and proven to reduce risk to an acceptable level by the Project owner (*impacts from hazards and responses are managed*)
- Therefore the residual level of risk should be (re)assessed
- If integrated throughout project development, "measures" may not be easy to abstract from a good project design. If undertaken later, (in a more audit-like approach) measures will be more of an "add-on" style.
- Consider flexible or adaptive management for adaptation supported by monitoring

Risk Analysis

Risk assessment conclusions and adaptation measures (1/2)

Climate hazard	**Flooding (fluvial, storm flush flood)**
Vulnerability	High
Probability	Possible
Impact (Consequences)	Disastrous Damage to road assets and other infrastructure, slope instability and landslides, risk of flooding, blocking of the road, traffic disruption, health and safety risks, inaccessibility for maintenance teams
Risk Score	**Extreme/ Very High**
Description of in-built resilience & proposed adaptation measures	The following design aspects have been considered to provide project in-built resilience: - Design standards for bridges to withstand 50 (100)-year floods - Consider if applying a climate factor for bridges and culverts (e.g. 10-20% increase of rainfall and/or increased clearance over 50 (100)-year flood levels under bridges); - Dedicated pumping station to channel flood and rain waters into a dedicated retention basin through two intake ditches at a specific project location where flooding has already happened in the past - Retention basin linked through rainwater pipeline with the cost where discharge is provided - Adequate design standards for road drainage system with considerable free margin - Consider if applying a climate factor for drainage systems (e.g. 10-20% increase of drainage capacity) - Adequate design of intermediate bridge supports and abutments, incl. avoidance of intermediate bridge supports in fast-flowing streams prone to

Constitute basis for further project stages, including **recommendations and/or aspects to be checked at project construction design based on CCVRA results and data**

(to be included in relevant design ToRs)

Risk Analysis

Risk assessment conclusions and adaptation measures (2/2)

Description of in-built resilience & proposed adaptation measures	The following measures for the related project resilience refer to the operation stage and, therefore, those will need to be implemented and/or part of the relevant operation and maintenance contracts/procedures of the road: - adequate routine maintenance of drainage and retentions systems and slopes including monitoring (and inspections) of drainage, bridge, culverts… - conditions to ensure drainage efficiency and capacity - adapt maintenance regime of roadside greenery to increased precipitation - continuous monitoring of flood risk according to which additional measures can be initiated - road management systems providing user warning and response systems (i.e., appropriate signalling and/or other information systems to inform on planned restrictions and/or rerouting), e.g. in case of certain road section being flooded or land stability issues affecting the road traffic - analysis of scouring risks for bridges including providing/justifying resilience measures to protect bridge supports and structures (to be undertaken as relevant for the planned bridges) - in case of relevant landslides risks, considerations related to increased heavy precipitation, that might conclude on need of monitoring, or specific technical studies
Residual risk	**Low (Inherent risk 20, Risk reduction 14, Residual risk 6)** The risk should be subject to **monitoring** to assess if measures in place need to be reconsidered.

Ensure measures are properly incorporated into the upcoming project development phases and implemented

Risk Analysis

Risk assessment conclusions and adaptation measures – additional considerations

Adaptation measures beyond specific project and/or project Beneficiary

- Importance of **systematic register of climate incidents** as a basis to:
  - inform CCVRA for other projects
  - revise O&M procedures, user warning and response systems
  - monitor need of additional adaptation measures
- Sound **maintenance strategy** with sustainable financing
- Parallel **review of design standards and practices**
  - CCVRA as a basis to justify going beyond minimum standards
- **Flood risk management plans** – sufficiently accounting climate forecasts?
- **Cooperation** with different stakeholders, institutions, administration levels

Climate Resilience Proofing Conclusions

Report on…

- Identified potential climate risks through screening
- Assessment of those through detailed analysis
- Identified relevant adaptation measures to mitigate assessed risks
  - Incl. implementation plan and relevant monitoring of risks as they evolve over time (uncertainty)

- Assess the consistency with relevant national and EU strategies and plans on adaptation
- Assess the consistency with relevant Regional/local adaptation strategies

CLIMATE RESILIENCE PROOFING

Golden Rule

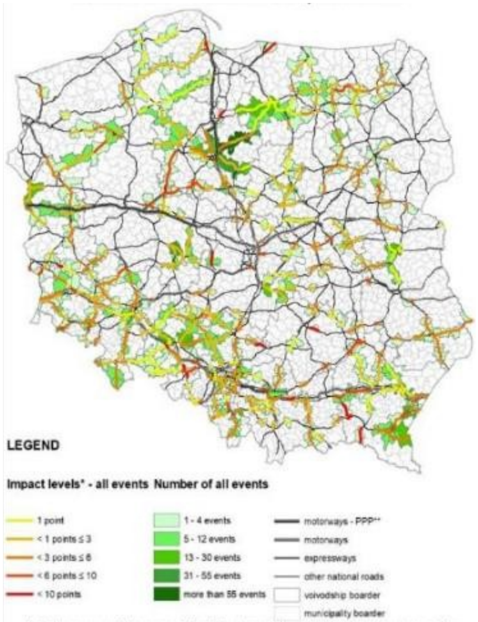
Integrate climate proofing concept into the project development cycle as early as possible:

- Ideally within strategy development or at the latest at the Feasibility Study stage.
- Initial climate proofing screening before options appraisal can help direct project development.
- Climate proofing documentation should not result in any surprises or a need to substantially alter a project.

Reality is not always ideal, still it's never too late to reflect on it and integrate it in upcoming preparatory processes

Road network climate resilience assessments

The case of Polish National Roads



Current climate change vulnerabilities

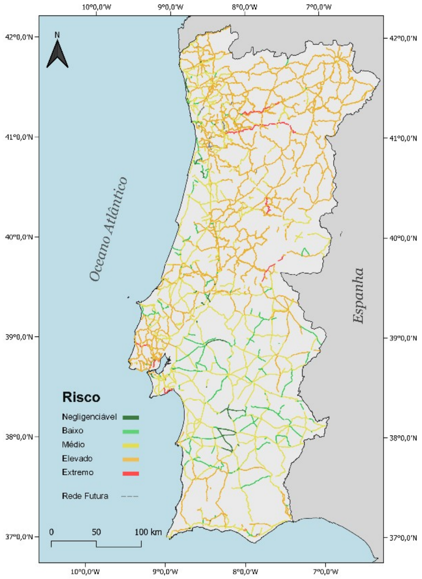
- 2017: Database of **extreme weather incidents** (>3,000 over 2004-2016) based on internal survey
  - Identifies current main climate hazards for national road network
    - Heavy Rain, Strong wind, Heavy snow, Flooding (pluvial/fluvial)
  - Majority of incidents occurred on national roads of lower class (not A & S)
  - Majority of incidents caused traffic disruptions
  - **GIS** is key to support vulnerability analysis
- **Mapping current climate vulnerabilities** of identified most relevant climate hazards: exposure (frequency of events) and sensitivity (damages, traffic disruptions)
- **Climate forecasts** & **workshops**-expert knowledge to assess future climate vulnerabilities
- Basis for “**Business case**”: robust economic justification for adaptation measures based on evidence data on impacts (damages costs & operation disruptions-users impacts)
- **Adaptation Action Plan** proposal
  - On-going discussions to identify pipeline of investments on climate adaptation considering planned upgrading programs

See:
Roads and Climate Change in Poland a case study.pdf (eib.org)
Adaptation to Climate Change for National Roads in Poland, GDDKiA
. Brussels, June 2019

Road network climate resilience assessments

The case of Infraestructuras de Portugal

Infraestruturas de Portugal
Ligamos destinos



- Covers road, rail and associated telematics networks
- Stage I: **Climate change vulnerability and risk analysis** *(completed)*
  - Climate change vulnerability assessment:
    - Based on climate incidents registers
    - Climate forecasts considerations
    - Identified main climate hazards (wildfires, extreme temperature, flooding, strong winds…)
  - Climate change risk assessment for relevant hazards
    - Probability assessed considering climate forecasts and studies (RCP4.5 & RCP8.5 scenarios and for current/mid-century/end-century)
    - Severity based on IP experts knowledge/experience on impacts (damages and service disruption)
    - Build on strong IP GIS tool
- Stage II: **Climate Adaptation Action Plan** *(on-going)*
    - 3 Pillars: Existing network, future investments, institutional framework
    - Best basis to inform CCVRA for new investments – increased IP capacity to undertake them
    - Identify immediate needs on climate adaptation
    - Governance for climate adaptation plan and stakeholders engagement

Road network climate resilience assessments

Some key benefits

Existing network management

- Identify **priority sections with climate adaptation investment needs – Opportunity** for climate adaptation financing on existing networks! (EU & EIB financing and advisory resources are available)
- Considerations for O&M – **user early warning and response systems** and **climate incidents registers** & monitoring
- Basis for **integrated management system** of the network incl. **criticality** considerations for measures

New developments

- Best **basis to inform CCVRA for projects** (from feasibility incl. option analysis to operation)- climate change resilience proofing (EU financing requirement & general good practice)
- **Identifies corridors exposed** at climate hazards
- **Climate change considerations for design** practices/procedures/ standards

Organisation, institutional & stakeholders

- **Increased internal capacity** on climate change resilience, awareness raising
- International knowledge exchange, recognized as **best practice**
- **Results of key interest** also for other parties (e.g. regional/local administrations) for adaptation plans/planning developments
- **Need of coordination** with other stakeholders (e.g. river basin management), design standards/legislation

*Aligned with __EU Climate Change Adaptation Strategy__ (EC 2021) aiming at smarter adaptation, faster adaptation, **more systemic adaptation** and stepping up international action for climate resilience.*

Thank you!

Marian Purtz
Senior Transport Engineer
(m.purtz@eib.org)

JASPERS
www.jaspers.eib.org

JASPERS Knowledge Platform
https://jaspers.eib.org/knowledge/index

European Investment Bank

Jaspers

European Commission