RISKADAPT
Modeling of Risks and Adaptation

Key results and guidelines for regulatory authorities and policy makers

This document provides a concise, non-technical overview of the key results of the RISKADAPT project and the associated guidelines developed to support evidence-based policy making, infrastructure planning, and climate adaptation strategies. The content is designed for regulatory authorities, public administrations, and decision makers at national, regional, and local levels.

Funded by the European Union

www.riskadapt.eu

Executive Summary

Climate change is increasing the frequency and intensity of extreme weather events, posing growing risks to critical infrastructure such as bridges, energy networks, transport systems, and healthcare facilities. Infrastructure failures can generate significant economic losses, disrupt essential services, and disproportionately affect vulnerable communities. Public authorities therefore require robust, forward-looking, and evidence-based tools to support climate-resilient infrastructure planning and investment decisions.

RISKADAPT delivers an integrated suite of methodologies, digital tools, and practical guidance to assess climate-induced risks at asset level and to identify effective, low-carbon adaptation strategies. The project combines climate projections, structural vulnerability assessment, life-cycle environmental and economic analysis, and social impact modelling within a single, coherent framework designed to support policy and decision-making.

RISKADAPT directly supports the implementation of key European and international policy frameworks. It contributes to the European Green Deal by enabling climate-resilient and low-carbon infrastructure planning, supporting renovation and circular economy objectives. It aligns with the Paris Agreement by strengthening adaptive capacity, informing risk-based investment decisions, and supporting transparent, evidence-based adaptation planning. It also advances the Sustainable Development Goals, particularly SDGs 9 (Industry, Innovation and Infrastructure), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), and 13 (Climate Action).

Key policy takeaways:

- Climate adaptation planning should be based on forward-looking, probabilistic risk assessments rather than historical data alone.
- Infrastructure investments must simultaneously address resilience, decarbonisation, and lifecycle sustainability.
- Social impacts and equity considerations are essential for effective and inclusive climate adaptation.
- Digital decision-support platforms can improve transparency, prioritisation, and cross-sectoral coordination.

Overview of Key Results

Integrated Risk Assessment Methodology

Climate change is intensifying extreme weather events, increasing the vulnerability of essential infrastructure across Europe. Public authorities need robust, science-based methodologies capable of assessing these risks and guiding long-term, climate-resilient investment decisions.

Short description of the project result

RISKADAPT's Methodology provides a systematic, scalable framework to evaluate the vulnerability of infrastructure assets under multiple climate-induced hazards, including wind, heavy rainfall, flooding, and icing. By integrating climate science, material degradation modelling, and structural analysis, the methodology estimates how assets deteriorate over time and how their fragility evolves under future climate scenarios. The methodology is intended to support public authorities in designing informed, risk-aware, and locally tailored adaptation strategies.

Advancement with respect to existing tools

Traditional vulnerability assessments often rely on past climate conditions and static material assumptions; RISKADAPT's approach incorporates future climate projections, yielding more reliable long-term predictions.

Policy call to action

- Integrate climate-informed vulnerability assessments into national and regional infrastructure planning, ensuring that public assets are evaluated against both current and future hazard conditions.
- Adopt multiscale, probabilistic assessment methods as part of regulatory requirements for the design, maintenance, and retrofitting of critical infrastructure.
- Prioritise investments in assets identified as high-risk, using methodology outputs to guide cost-effective and sustainable adaptation interventions.
- Support capacity building for engineers, planners, and civil protection authorities to apply advanced climate–structural assessment methods.

The methodology addresses four main climate-induced hazard which are of relevance for assets vulnerability and are linked to the real word case studies of RISKADAPT, specifically:

Hydrological and hydraulic modelling for flood impacts on bridges:

Using extreme rainfall scenarios, it has been shows that hydrodynamic loads on bridges remain low due to reservoir depth, while highlighting the need for improved bathymetric data. The study offers a replicable method for climate-informed flood risk assessment of critical assets.

Climate-driven icing and wind risk for electricity grids:

High-resolution climate modelling shows that although average icing decreases, extreme events remain a threat for power transmission lines.

The integrated assessment supports energy operators and authorities in planning climate-resilient grid investments.

High-resolution modelling of wind and rain loads on buildings:

A multiscale numerical simulations links regional climate data with building-scale simulations to estimate wind and rain pressures on tall structures.

The final output is a set of semi-empirical functions enabling fast and reliable assessment of atmospheric loads on building façades.

Algorithms and digital tool for predicting glass failure in high-rise buildings:

Numerical simulations and probabilistic models quantify the likelihood of window glass breakage under extreme winds, addressing a recurring hazard in dense urban areas.

An online platform makes these assessments accessible to building managers and regulators

PRINTED: Structural vulnerability and material degradation under climate-induced hazards

As climate change intensifies, public authorities increasingly need tools that evaluate not only the technical robustness of infrastructure, but also its environmental and economic viability over time. The PRINTED approach provides a unified, forward-looking method to support climate-resilient, low-carbon, and cost-effective adaptation planning.

Short description of the project result

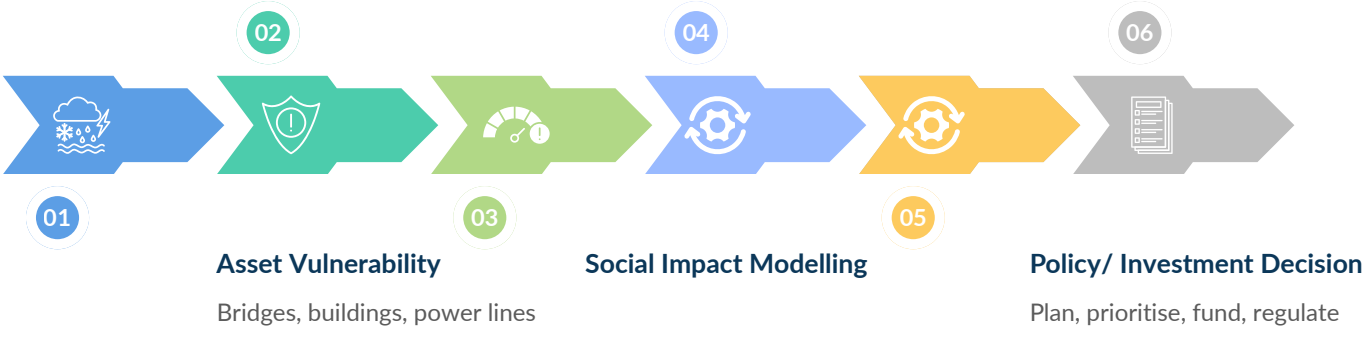
As climate change intensifies, public authorities increasingly need tools that evaluate not only the technical robustness of infrastructure, but also its environmental and economic viability over time. The PRINTED approach provides a unified, forward-looking method to support climate-resilient, low-carbon, and cost-effective adaptation planning.

Advancement with respect to existing tools

Existing tools generally assess environmental or economic impacts in isolation, whereas PRINTED provides a fully integrated system, linking climate science, structural engineering, environmental sustainability, and financial decision-making. PRINTED also offers location-specific and structure-specific outputs, enabling tailored adaptation strategies that reflect local hazard profiles and infrastructure characteristics.

Policy call to action

- Integrate PRINTED into national and regional infrastructure adaptation planning, ensuring that public investment decisions reflect long-term climate risks, environmental impacts, and economic performance.
- Promote probabilistic Life Cycle Assessment & Costing assessments in the design, renovation, and procurement of critical infrastructure, especially in sectors exposed to intensifying climate hazards (transport, energy, health facilities).
- Support adoption through regulatory guidance and capacity-building, enabling engineers, planners, and public agencies to apply PRINTED-based methods in compliance with the European Green Deal, EU Taxonomy, and climate adaptation frameworks.
- Use PRINTED results to prioritise low-carbon and resilient adaptation measures, aligning infrastructure decisions with national climate objectives and long-term sustainability targets.



PRISKADAPT: User-friendly interface for integrated risk and adaptation visualisation

As climate-related hazards intensify, public authorities need integrated tools capable of translating complex scientific data into clear, actionable insights for infrastructure planning and adaptation. The PRISKADAPT platform provides a unified digital environment that supports evidence-based decision-making by combining engineering, climate, environmental and social information.

Short description of the project result

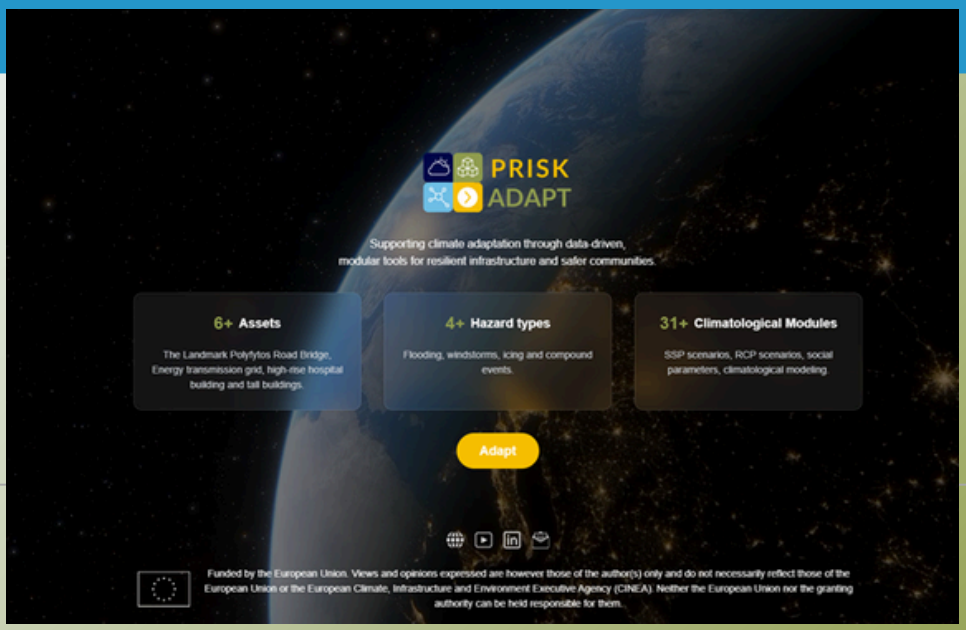
PRISKADAPT is an integrated digital platform designed to assess climate risks to infrastructure assets and identify the most effective adaptation strategies. It brings together climate hazard data, structural vulnerability models, environmental and economic indicators, and social impact assessments into a coherent decision-support ecosystem. By enabling scenario comparison and prioritisation of interventions, the platform helps authorities plan resilient, sustainable, and future-proof infrastructure.

Advancement with respect to existing tools

PRISKADAPT offers a single integrated environment where all dimensions of climate risk are combined. It moves beyond deterministic approaches by incorporating probabilistic hazard data, multi-criteria assessment, and adaptation scenario modelling, aligned with EU adaptation and sustainable finance frameworks.

Policy call to action

- Strengthen cross-agency collaboration by integrating PRISKADAPT into workflows for transport, energy, civil protection, and urban planning authorities.
- Support capacity-building initiatives to familiarise public officials with probabilistic risk assessment, multi-criteria evaluation, and digital adaptation planning.
- Promote regulatory alignment by using PRISKADAPT-generated indicators to support compliance with the European Green Deal, Climate Adaptation Strategy, and EU Taxonomy for sustainable infrastructure.



Social Impact Modelling of infrastructure disruption using spatial microsimulation

Climate-related disruptions to infrastructure affect not only physical assets but also the well-being, accessibility, and daily lives of communities. Public authorities increasingly require tools that capture these social consequences at a fine spatial scale to ensure equitable, people-centred climate adaptation planning.

Short description of the project result

The localised Social Impact Modelling framework quantifies how disruptions to critical infrastructure (e.g. bridges, hospitals, and electricity grids) affect socio-economic conditions and well-being. The method generates detailed synthetic populations for small areas, enabling assessments that reflect local demographic diversity and vulnerability. The result is a flexible, replicable approach that supports public authorities in identifying socially equitable and targeted adaptation options.

Advancement with respect to existing tools

Most current infrastructure risk assessments focus on physical or economic damage alone; Social Impact Modelling advances this by embedding people-centred metrics into climate adaptation evaluations. Existing social vulnerability indices often rely on coarse geographic units, whereas this approach provides high-resolution, localised insights into how specific communities are affected. The modelling framework is replicable across regions and asset types, offering authorities a scalable and adaptable tool for integrating social dimensions into climate resilience strategies.

Policy call to action

- Integrate social impact modelling into all stages of climate adaptation planning, ensuring that decisions consider well-being, equity, and accessibility alongside physical risk.
- Use localised vulnerability maps to prioritise adaptation measures for communities most affected by infrastructure disruptions, improving fairness and resource allocation.
- Promote cross-sectoral coordination between infrastructure managers, social services, and urban planners to ensure coherent, community-focused adaptation strategies.
- Support the development of national datasets enabling systematic application of spatial microsimulation for social impact assessment.
- Embed social outcome indicators into adaptation funding frameworks, aligning with the European Green Deal's commitment to a just and inclusive transition

Materials and components passports for circular and climate-resilient assets

As climate change increases pressures on infrastructure, authorities need reliable, transparent, and standardised information on the materials that compose public assets. Material Passports provide data-driven support for sustainable, circular, and climate-resilient infrastructure planning.

Short description of the project result

The Material Passports integrates physical, mechanical, environmental, and economic information on construction materials into a centralised, Building Information Modelling compatible database. Material Passports acts as dynamic digital records that track material condition, performance, and suitability for adaptation across the asset lifecycle. This enables public authorities to make informed decisions about maintenance, retrofitting, material substitution, and long-term resilience planning.

Advancement with respect to existing tools

Current material registries are often fragmented, static, or incompatible with digital design tools; the RISKADAPT's Material Passports introduces a fully interoperable, dynamic, and automation-enabled system aligned with EU digitalisation and circularity initiatives.

Policy call to action

- Mandate the use of Material Passports in public infrastructure projects to ensure consistent, transparent, and standardised data across the asset lifecycle.
- Align Material Passports with EU Digital Product Passport and Circular Economy Action Plan requirements, promoting material traceability, reuse, and low-carbon construction.
- Integrate Material Passports into renovation and resilience strategies, enabling authorities to compare baseline and adaptation scenarios with quantifiable environmental and economic evidence.
- Promote interoperability and open standards, ensuring that public-sector digital tools communicate effectively across agencies and Member States.

Library of low-carbon adaptation options for precast concrete structures

The Library of Low-Carbon Structural Adaptation Options provides a curated set of practical, sustainable solutions to strengthen the resilience of infrastructure under evolving climate conditions. It guides decision-makers in selecting low-carbon, circular, and technically effective measures to extend asset lifespan while reducing environmental impacts.

Short description of the project result

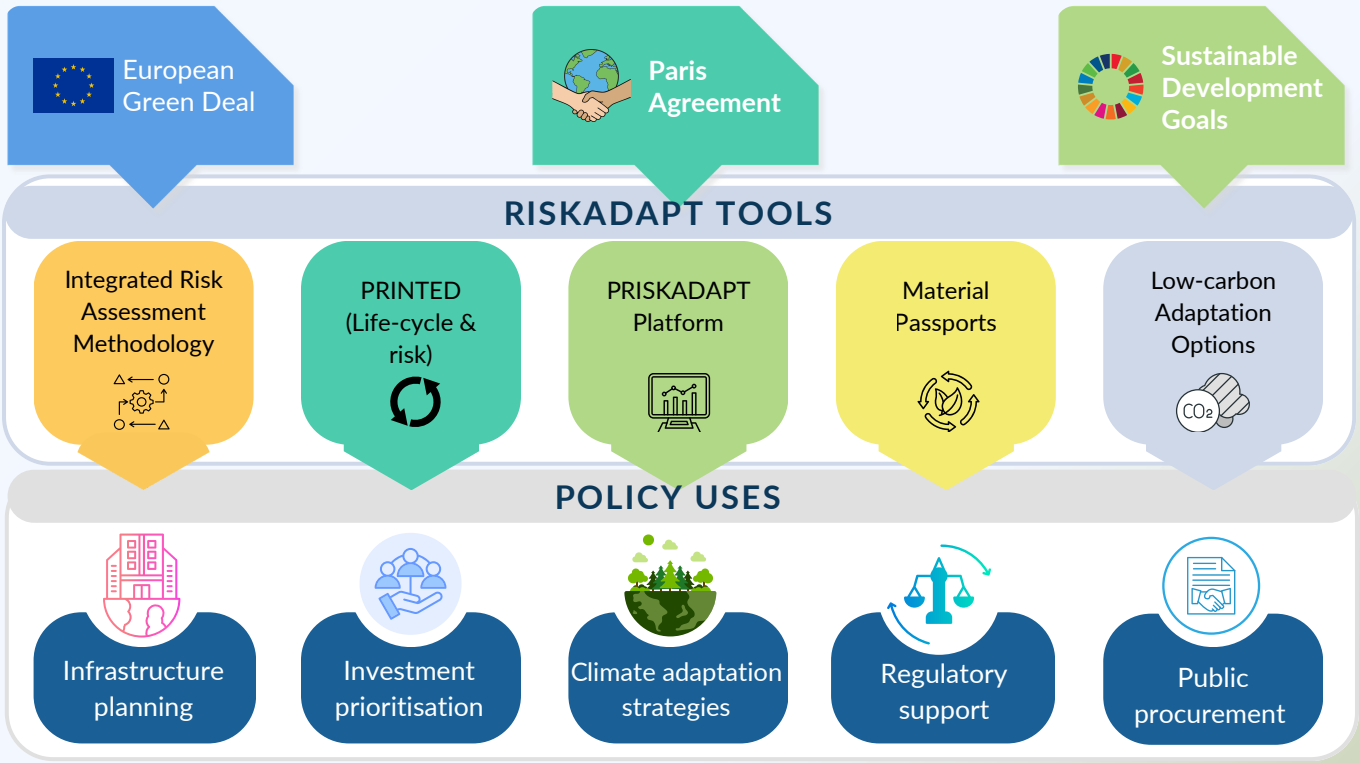
The library compiles a set of engineering solutions that both enhance the climate resilience of infrastructure and reduce embodied carbon in construction and refurbishment activities. Drawing on climate-informed degradation modelling and real-world applications, the library enables infrastructure owners and public authorities to select effective, low-impact adaptation measures tailored to future environmental conditions.

Advancement with respect to existing tools

The library integrates climate-adjusted degradation models with a comprehensive set of low-carbon adaptation solutions, enabling simultaneous assessment of structural resilience and embodied environmental impacts. Unlike traditional retrofit catalogues or static engineering guidelines, it provides future-oriented, multi-hazard evaluations grounded in predictive modelling and lifecycle thinking.

Policy call to action

- Integrate low-carbon structural adaptation options into renovation policies, infrastructure management strategies, and climate adaptation plans.
- Require or incentivise the use of climate-adjusted degradation modelling and lifecycle-based assessment in regulatory processes, standards, and public procurement.
- Promote the uptake of circular, low-carbon materials and retrofit solutions through targeted guidance, financial instruments, and regulatory alignment.
- Support harmonised methodologies across Member States to ensure consistent, climate-resilient and sustainable infrastructure investment decisions.
- Foster collaboration between public authorities, industry, and research organisations to accelerate the deployment and scaling of innovative adaptation solutions.



Key Messages for Authorities

Climate adaptation planning should be evidence-based and cross-sectoral.
Infrastructure investments must align with low-carbon and circular economy objectives.
Social impacts should be systematically assessed to ensure equitable resilience.
Static assessment approaches should be replaced by probabilistic, forward-looking methods.
Digital platforms improve transparency and accessibility in decision-making.

Actionable Recommendations

Integrate RISKADAPT tools into national and regional adaptation strategies.
Prioritise high-risk assets using probabilistic assessment outputs.
Promote capacity-building for public authorities.
Encourage life-cycle-based assessments and Material Passports in public procurement.
Systematically adopt low-carbon adaptation options aligned with regulatory frameworks.

Further Information

Public deliverables and technical documentation are available at: https://riskadapt.eu/public-deliverables/
Related technical report: https://riskadapt.eu/wp-content/uploads/2024/07/CERIB-Report-044166-A-BIBM-2.pdf