



WORKING PAPER

**SEVENTH WORLDWIDE AIR TRANSPORT CONFERENCE
(ATCONF/7)**

Montréal, HQ, 16 to 20 November 2026

**Agenda Item 4: Emerging technologies, new business models and other associated aspects
4.2: Support and economic opportunities of access to aviation cleaner energies**

**INTEGRATING CLIMATE RESILIENCE INTO AIRPORT PLANNING:
A PERFORMANCE-BASED APPROACH**

(Presented by Italy)

EXECUTIVE SUMMARY

Climate adaptation is increasingly a prerequisite for reliable, sustainable and investable airport development. This paper proposes a performance-based model for integrating climate resilience into airport Master Plans and infrastructure investment decisions. Site-specific climate scenarios and risk assessments are translated into two complementary KPIs: one measuring airport-wide resilience and one measuring the contribution of individual planned interventions. Italian airport case studies illustrate both the upstream risk-assessment component and the downstream translation of climate projections into design criteria, project scope and investment needs. The framework connects these stages to project identification, preparation, comparison, prioritization and monitoring, making resilience an explicit dimension of long-term infrastructure sustainability while preserving flexibility for different airport contexts.

Action: The conference is invited to:

- a) recognize that climate resilience should be integrated into airport Master Plans and infrastructure investment decisions as a measurable performance objective;
- b) encourage States and airport planners to adopt risk- and performance-based approaches, calibrated to local climate scenarios and airport criticality, to compare the resilience benefits of planned interventions and support project prioritization; and
- c) request ICAO to consider, in coordination with States and industry, scalable methodologies and indicators for incorporating climate resilience into infrastructure project identification, preparation, prioritization and monitoring, building on existing climate-risk guidance.

<i>Strategic Goals:</i>	This working paper relates to Strategic Goals: <i>The Economic Development of Air Transport Assures the Delivery of Economic Prosperity and Societal Well-Being for All and Aviation is Environmentally Sustainable.</i>
<i>Financial implications:</i>	The activities referred to in this paper will be undertaken subject to the resources available in the Regular Budget and/or from extra-budgetary contributions, including the Voluntary Air Transport Fund (TRAF).

<i>References:</i>	Assembly Resolution A42-21 – <i>Consolidated statement of continuing ICAO policies and practices related to environmental protection – Climate change</i> ICAO Strategic Plan 2026–2050 ICAO (2022) – Climate Change: Climate Risk Assessment, Adaptation and Resilience ICAO Doc 9184, <i>Airport Planning Manual</i> , Part 1 – Master Planning (3rd ed., 2023) ISO 14091:2021 – Adaptation to climate change — Guidelines on vulnerability, impacts and risk assessment
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1. INTRODUCTION

1.1 Climate change increasingly affects airport infrastructure performance, service life and reliability. Changes in temperature, precipitation, wind patterns and extreme events can disrupt operations, increase maintenance needs and alter lifecycle value. Infrastructure development can therefore be sustainable only if assets and critical services remain functional under changing climate conditions. Resilience should enter the earliest planning stages, not as a separate environmental requirement but as a variable alongside safety, capacity, environmental and economic performance, informing project identification, preparation and prioritization.

1.2 Assembly Resolution A42-21 recognizes the vulnerability of international aviation systems and infrastructure to projected climate impacts and calls for climate-risk assessment, adaptation measures and climate-resilient development. Existing ICAO guidance and ISO 14091:2021 provide a robust basis for climate-risk assessment. Previous Italian contributions to the 42nd Session of the ICAO Assembly addressed complementary elements: A42-WP/517 focused on climate resilience and risk assessment, while A42-WP/518 introduced a performance-based model for sustainable and digital airport planning based on standardized KPIs. A remaining implementation challenge is to connect these elements to Master Plan choices and investment decisions in a transparent and comparable way.

1.3 This paper connects those principles by translating climate risk into planning performance. It does not prescribe uniform adaptation measures, since climate risk is highly site-specific. Instead, the framework establishes a common decision logic and measurable outcomes while leaving airports free to select the technical, operational and digital solutions most appropriate to their local context.

2. FROM CLIMATE RISK TO PLANNING PERFORMANCE

2.1 The proposed process starts by aligning climate scenarios and time horizons with the airport planning horizon. Relevant hazards are screened and mapped against airport assets, systems and operational processes. Exposure, vulnerability, criticality and adaptive capacity are assessed so that climate projections become residual risks and measurable resilience needs. The analysis covers direct infrastructure impacts and indirect effects on operational continuity, access, utilities and other critical dependencies, turning climate-risk assessment into a direct input to planning.

2.2 A two-level KPI architecture is introduced, extending the logic already used by ENAC for sustainable and digital airport planning. An Overall Airport Climate Resilience KPI would synthesize resilience across critical assets and functions, taking account of residual risk and adaptive capacity. A Climate Resilience Intervention Impact KPI would quantify the expected contribution of each planned intervention to reducing residual risk or increasing adaptive capacity under the selected climate scenarios.

2.3 The indicators should be based on traceable data and transparent assumptions, with weighting reflecting asset criticality and the operational consequences of failure. Their purpose is not to create a single prescriptive global benchmark, but to establish an airport-specific baseline, measurable targets and a comparable delta produced by alternative projects or portfolios. This preserves local flexibility while enabling decision-makers to identify no-regret measures, compare design options and test development paths under different climate futures.

2.4 Resilience performance should be periodically reassessed as climate information, traffic, infrastructure configuration and operational requirements evolve. Monitoring closes the planning loop: climate scenarios lead to risk assessment; risk assessment defines performance needs; planned interventions are evaluated against those needs; and observed performance is used to update priorities and the next planning cycle.

2.5 Effective KPI-based planning requires clear organizational accountability. Airport operators should designate a Sustainability Manager, or equivalent function, responsible for the sustainability KPI framework, including data governance, baselines, targets and periodic monitoring. The same function should oversee climate-resilience KPIs and ensure that results feed into Master Plan updates and investment prioritization, integrating resilience into the airport's overall sustainability management system.

3. APPLICATION TO ITALIAN AIRPORT SYSTEMS

3.1 The ADR Roma Airports experience reported in A42-WP/517 provides the upstream risk-assessment component. Under ENAC oversight, ADR developed a Climate Change Risk Analysis methodology aligned with ICAO guidance and ISO 14091:2021. It combines climate scenarios, EU Taxonomy hazard screening, identification of critical assets such as runways, taxiways, aprons and drainage systems, and assessment of exposure, sensitivity and capacity to adapt. Dynamic risk modelling then supports measures grouped into design, monitoring, maintenance and equipment, establishing the risk baseline and adaptation options required for subsequent planning.

3.2 The SEA Milan Airports experience provides the complementary link from risk assessment to planning and project development. SEA's Climate Change Adaptation Plan combines climate analysis, climate-risk assessment, adaptation measures, monitoring and review, using 2040 and 2060 horizons under RCP4.5 and RCP8.5. At Malpensa Airport, the intense rainfall event of 26 August 2024 caused about one hour of operational interruption, 37 cancellations and 113 flights with significant delays, demonstrating the materiality of climate-related hazards.

3.3 SEA's Re-MXP programme shows how climate projections can alter design criteria, project scope and investment needs. For drainage design, the reference event was increased to a 50-year return period, approximately 80 per cent above the previous reference, requiring storage capacity about 33 per cent greater than under current criteria. Together with smart monitoring, this demonstrates how climate-risk information can directly change the technical and financial characteristics of an intervention.

3.4 Together, the cases represent successive stages: ADR establishes an airport-specific risk baseline and adaptation options; SEA shows how climate information can change design standards, project scope and investment requirements. The proposed KPIs bridge these stages by associating interventions with expected reductions in residual risk or increases in adaptive capacity, enabling comparison and ranking by contribution to long-term resilience. KPI weights and calibration should be tested against airport infrastructure and operational data.

4. INVESTMENT PRIORITIZATION AND FINANCING

4.1 Embedding resilience performance into Master Plan appraisal makes climate resilience an explicit and comparable dimension of overall infrastructure sustainability, alongside safety, capacity, environmental, economic, social and project-maturity considerations. An intervention-level resilience KPI does not replace cost-benefit analysis; it adds a traceable layer showing whether an intervention can preserve functionality, operational continuity and long-term asset value under changing climate conditions, including where alternatives appear similar under conventional appraisal criteria.

4.2 Quantifying expected climate-risk reduction and residual risk strengthens project identification, preparation and prioritization by making resilience benefits explicit before investment decisions are finalized. Resilience thus becomes an additional decision variable in assessing whether an intervention is sustainable over its lifecycle, together with economic viability, environmental performance, social effects, safety and capacity. This can support the justification of additional lifecycle expenditure, improve investment transparency and strengthen the bankability of adaptation measures, while facilitating access to development, climate or blended-finance instruments where resilience benefits are demonstrable.

4.3 The approach should be multi-stakeholder by design because information on systemic vulnerabilities is distributed across airport operators, civil aviation authorities, air navigation service providers, local and regional authorities, utilities, emergency services and financing institutions. Their involvement improves project preparation and the credibility of resilience assumptions used in appraisal. Digital monitoring can strengthen the evidence base, verify expected benefits and update resilience performance without changing the fundamental planning logic.

5. CONCLUSION

5.1 The Italian experience suggests that the next practical step in aviation climate adaptation is to move from climate-risk assessment to performance-based investment planning within airport Master Plans. The proposed framework links climate scenarios and vulnerabilities to measurable resilience needs, resilience KPIs, project selection, investment prioritization and periodic monitoring.

5.2 ADR and SEA illustrate complementary parts of this process. ADR establishes the climate-risk baseline and adaptation options; SEA shows how climate projections can change design criteria, project scope and investment requirements. The objective is not to standardize local solutions, but to provide a consistent basis for measuring their contribution to resilience. Pilot applications would allow weights and thresholds to be calibrated while preserving flexibility for different data availability and operational complexity.

5.3 Integrating climate resilience into airport planning therefore makes it a measurable variable of infrastructure sustainability and directly links climate-risk assessment to investment decisions. Modernization projects can thus be assessed also for their ability to preserve safe connectivity, infrastructure value and operational continuity throughout their lifecycle.