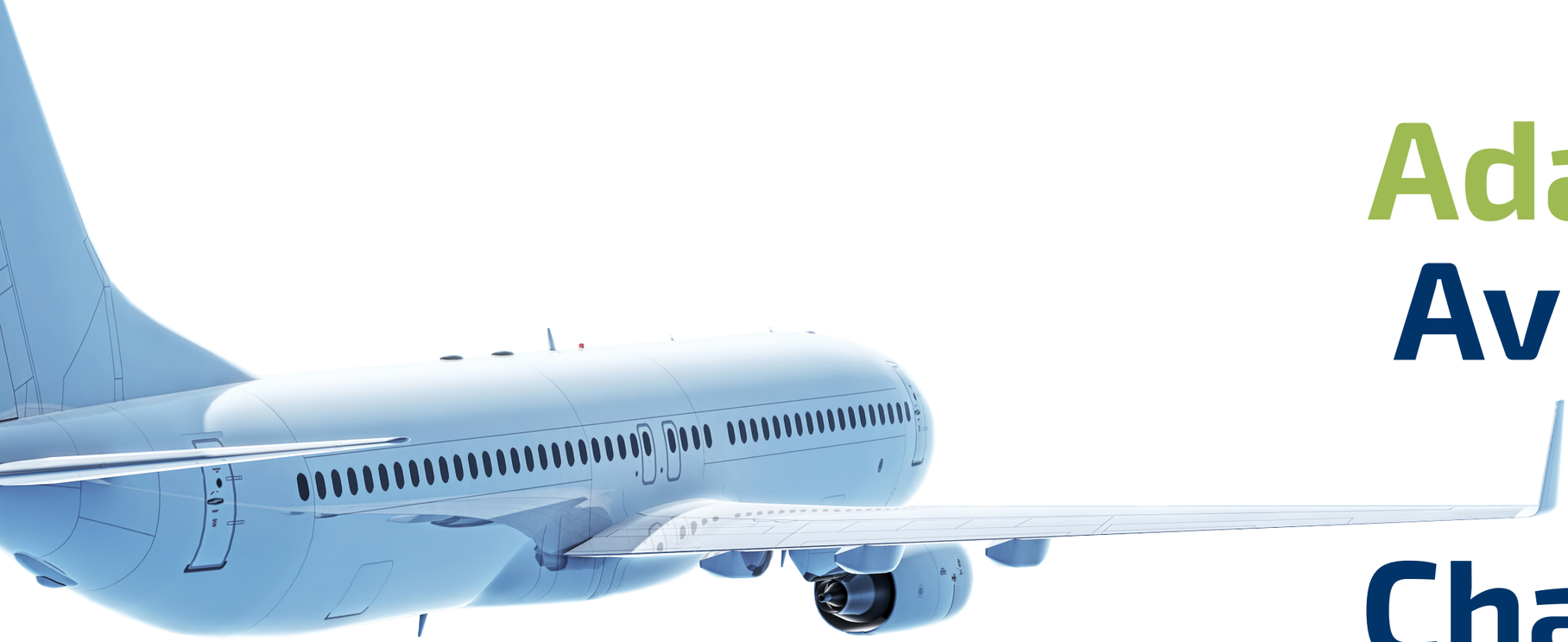
ACI EUROPE
AIRPORTS COUNCIL INTERNATIONAL

EUROCONTROL

Adapting Aviation to a Changing Climate

Effects and impacts of climate change for aviation



Adapting Aviation TO A Changing Climate

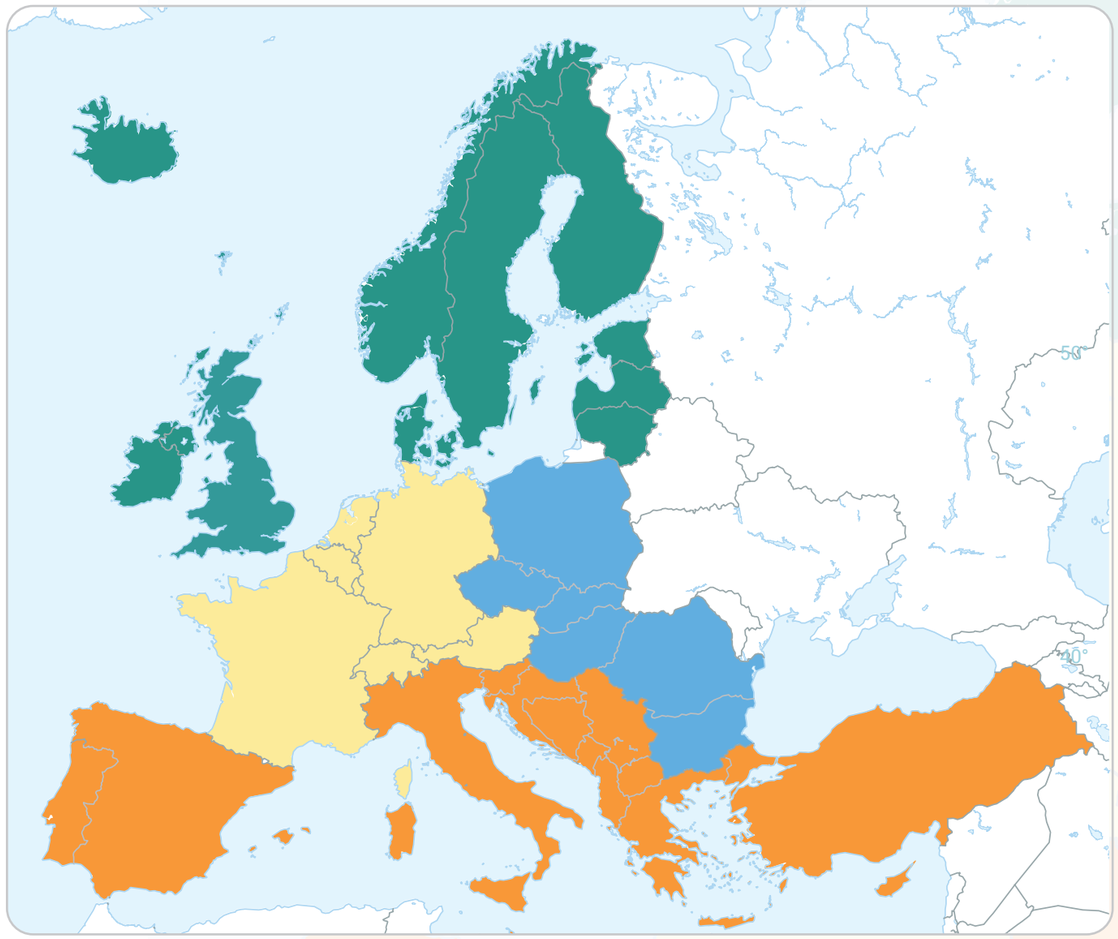
Effects and impacts of climate change for aviation

The global aviation sector is committed to achieving net zero CO_2 emissions and has set ambitious targets to do so. But even if net zero was achieved today, climate change effects will still be experienced and will impact aviation operations, infrastructure, passengers and personnel. Aviation already deals with disruptive weather on a regular basis. However such disruption is likely to become more extreme and more frequent as the impacts of climate change accelerate. So how can the aviation industry ensure the resilience of its infrastructure and the provision of safe, reliable passenger and cargo services in the future?

This factsheet identifies some of the key effects and impacts of climate change for airports, ANSPs and airlines[1] and provides a starting point for carrying out a climate change risk assessment. Please see the resource list for more information.

[1] *Note that these are selected examples only and the significance of these impacts will vary according to climate zone, geographical location and type of operations.*

[2] *The impacts of climate change on aviation can also be a health risk to passengers and personnel*



The impacts of climate change have consequences for the provision of aviation services. They are also increasingly being translated into financial impacts for risk assessment and sustainability reporting purposes. It is also possible that climate change will impact the demand for those services due to geographical or seasonal shifts in tourist passenger demand driven by changing temperatures and conditions at popular destinations e.g. hotter temperatures, sea level rise or reduced snow-cover.

The climate zones are based on the European Environment Agency European Climate Risk Assessment

EFFECTS IMPACTS

Northern Europe

- Higher average temperatures
- Increase in heatwave days
- Increase in total and heavy precipitation
- Decrease in snow cover and permafrost
- Increased cooling demand in terminals and aircraft
- Damage to infrastructure from stronger storms
- Increased flooding risk from heavy precipitation
- Increased traffic disruption due to stronger storms and heavy precipitation

Central-eastern Europe

- Higher average temperatures
- Increase in heatwave days
- Increase in heavy precipitation
- Increase in convective weather (thunderstorms/lightning)
- Increased cooling demand in terminals and aircraft
- Damage to infrastructure from stronger storms
- Increased flooding risk from heavy precipitation
- Increased traffic disruption due to stronger storms and heavy precipitation

Western Europe

- Higher average temperatures
- Increase in heatwave days
- Decrease in total precipitation / increase in heavy precipitation
- Increase in convective weather (thunderstorms/lightning)
- Increased cooling demand in terminals and aircraft
- Damage to infrastructure from stronger storms
- Increased flooding risk from heavy precipitation
- Increased traffic disruption due to stronger storms and heavy precipitation

Southern Europe

- Higher average temperatures
- Increase in heatwave days
- Decrease in total precipitation / Increase in heavy precipitation
- Increase in convective weather (thunderstorms/lightning)
- Increased cooling demand in terminals and aircraft
- Heat stress for passengers and personnel
- Damage to infrastructure (e.g. pavement) from heat
- Increased flooding risk from heavy precipitation
- Increased traffic disruption due to stronger storms and heavy precipitation

Coastal Zones

- Sea-level rise
- More frequent and/or more intense storm surges
- Temporary or permanent loss of airport capacity
- Increased traffic disruption due to more frequent and more intense storm surges

Key climate change impacts for airports, ANSPs and airlines

Airports ANSPs Airlines People (passengers and personnel)

CLIMATE EFFECT[3]	IMPACTS	Airports	ANSPs	Airlines	People
CHANGES IN AVERAGE AND EXTREME TEMPERATURES	• Changes in aircraft performance	●	●	●	
	◦ Decreased aircraft performance e.g. climb				
	◦ Increased take off distance or less weight				
	◦ Reduction in MTOM				
	◦ Changes in noise impact				
	• Heat damage to airports (runway, taxiway)	●			
	• Heat stress for personnel and passengers	●	●	●	●
	◦ Increased cooling requirements				
	◦ Lack of capacity in HVAC systems / potential failure of cooling systems				
	• Disruption to ground transport access	●	●	●	●
	• Increased probability of wildfires	●	●	●	●
	• Increase in disease vectors from climate change providing a newly hospitable environment for imported species.	●			
CHANGES IN FREQUENCY AND INTENSITY OF STORMS	• Disruption to operations: delays, cancellations, route extensions, diversions, reduction in en-route capacity and airport throughput	●	●	●	●
	• Disruption to ground transport access (passengers and staff)	●	●	●	●
	• Injuries to passengers and staff, including those caused by turbulence	●		●	●
	• Disruption to supply of utilities e.g. power outages	●	●	●	●
	• Increased risk of lightning strikes (personnel, aircraft airport infrastructure)	●		●	●
CHANGES IN PRECIPITATION	• Inadequate drainage system capacity:	●	●	●	
	◦ flooding of airfield and/or infrastructure				
	◦ Inundation of surface and underground infrastructure (e.g. electrical)				
	• Disruption to operations: delays, cancellations, reduction in airport throughput, diversions	●	●	●	●
	• Inundation of ground transport access (passengers and staff)	●	●	●	●
	• Reduced water availability due to drought	●	●	●	●
	• Pollution due to too much or too little precipitation	●			
	• Damage to underground infrastructure due to drying	●	●		
CHANGES IN WIND	• Disruption to operations: delays, cancellations, route extensions; diversions; temporary loss of capacity	●	●	●	●
	• Injuries to passengers and staff (including those caused by turbulence)	●	●	●	●
	• Damage to infrastructure and equipment	●	●	●	
	• Disruption to ground transport access	●	●	●	●
	• Disruption to supply of utilities e.g. power outages	●	●	●	●
	• Increase in en-route turbulence			●	●
	• Changes to optimal flight routes: impacts for ATC workload and staffing		●	●	
SEA LEVEL RISE	• Inundation of airfield and/or airport infrastructure	●	●	●	●
	◦ Loss of capacity (temporary or permanent)				
	◦ Disruption to operations: delays, cancelations, diversions				
	• Temporary/permanent inundation of ground transport access	●	●	●	●
CHANGES IN BIODIVERSITY	• Increased risk of birdstrikes	●	●	●	
	• Infectious diseases from new vectors (e.g. dengue)	●		●	●
CHANGES IN ICING	• Decrease in de-icing requirements in regions experiencing warmer winters	●		●	●
	• Increase in unexpected extreme icing events	●	●	●	●
DESERTIFICATION	• Increased dust storms or sand storms	●	●	●	●

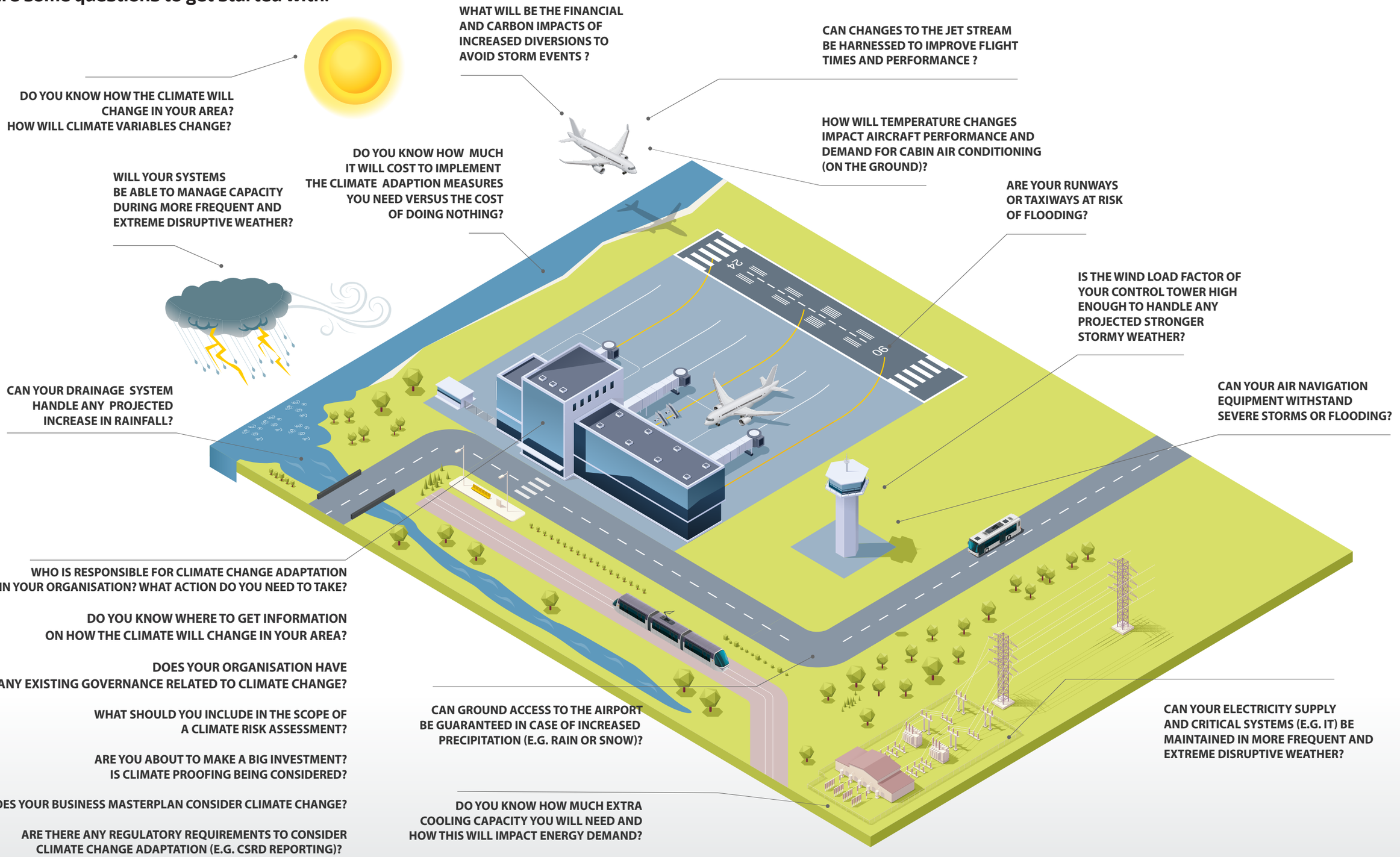
Climate-related hazards consist of "acute" climate-related (extreme) events and "chronic" climate trends that change over time (e.g. slow-onset events). For example, acute temperature events include heatwaves, wildfires and cold waves. For precipitation this includes drought, heavy precipitation and floods.

Chronic climate hazards for temperature include average and extreme temperature increase, heat stress and permafrost thawing. For wind this includes changing wind patterns and for water increases or decreases in mean precipitation and sea level rise.

[3] *Based on the 2018 ICAO Climate Adaptation Synthesis*

Assessing Climate Change Risks for your Organisation

How can you assess whether climate change impacts will be a risk for your organisation?
Here are some questions to get started with.



DO YOU KNOW HOW THE CLIMATE WILL CHANGE IN YOUR AREA? HOW WILL CLIMATE VARIABLES CHANGE?

WHAT WILL BE THE FINANCIAL AND CARBON IMPACTS OF INCREASED DIVERSIONS TO AVOID STORM EVENTS ?

CAN CHANGES TO THE JET STREAM BE HARNESSED TO IMPROVE FLIGHT TIMES AND PERFORMANCE ?

HOW WILL TEMPERATURE CHANGES IMPACT AIRCRAFT PERFORMANCE AND DEMAND FOR CABIN AIR CONDITIONING (ON THE GROUND)?

WILL YOUR SYSTEMS BE ABLE TO MANAGE CAPACITY DURING MORE FREQUENT AND EXTREME DISRUPTIVE WEATHER?

DO YOU KNOW HOW MUCH IT WILL COST TO IMPLEMENT THE CLIMATE ADAPTION MEASURES YOU NEED VERSUS THE COST OF DOING NOTHING?

ARE YOUR RUNWAYS OR TAXIWAYS AT RISK OF FLOODING?

IS THE WIND LOAD FACTOR OF YOUR CONTROL TOWER HIGH ENOUGH TO HANDLE ANY PROJECTED STRONGER STORMY WEATHER?

CAN YOUR DRAINAGE SYSTEM HANDLE ANY PROJECTED INCREASE IN RAINFALL?

CAN YOUR AIR NAVIGATION EQUIPMENT WITHSTAND SEVERE STORMS OR FLOODING?

WHO IS RESPONSIBLE FOR CLIMATE CHANGE ADAPTATION WITHIN YOUR ORGANISATION? WHAT ACTION DO YOU NEED TO TAKE?

DO YOU KNOW WHERE TO GET INFORMATION ON HOW THE CLIMATE WILL CHANGE IN YOUR AREA?

DOES YOUR ORGANISATION HAVE ANY EXISTING GOVERNANCE RELATED TO CLIMATE CHANGE?

WHAT SHOULD YOU INCLUDE IN THE SCOPE OF A CLIMATE RISK ASSESSMENT?

ARE YOU ABOUT TO MAKE A BIG INVESTMENT? IS CLIMATE PROOFING BEING CONSIDERED?

DOES YOUR BUSINESS MASTERPLAN CONSIDER CLIMATE CHANGE?

ARE THERE ANY REGULATORY REQUIREMENTS TO CONSIDER CLIMATE CHANGE ADAPTATION (E.G. CSRD REPORTING)?

CAN GROUND ACCESS TO THE AIRPORT BE GUARANTEED IN CASE OF INCREASED PRECIPITATION (E.G. RAIN OR SNOW)?

DO YOU KNOW HOW MUCH EXTRA COOLING CAPACITY YOU WILL NEED AND HOW THIS WILL IMPACT ENERGY DEMAND?

CAN YOUR ELECTRICITY SUPPLY AND CRITICAL SYSTEMS (E.G. IT) BE MAINTAINED IN MORE FREQUENT AND EXTREME DISRUPTIVE WEATHER?

Getting started with climate risk assessment and adaption

The following outline sets out key steps in carrying out a climate change risk assessment and developing an adaptation plan. Organisations should seek more detailed guidance[4] before embarking on their own adaptation and resilience journey.

The aviation sector is highly interconnected. Any disruption in one location can have an impact across the network. It is essential for all sector stakeholders to assess climate risks and implement adaptation measures. ACI EUROPE, EUROCONTROL and other aviation organisations are already taking action and progress is being made. But further action is necessary to ensure the maximum resilience achievable across the network.

1. Compliance check: identify any relevant national legislation and reporting requirements (e.g national reporting requirements, TCFD, CSRD).
2. Assemble the team: designate responsible individuals and departments, including operations, safety, business managers and key stakeholders.
3. Select a risk assessment methodology: choose between the organisation's existing risk assessment framework or an external climate risk assessment methodology.
4. Understand local climate change projections: work with local meteorological organisations to identify climate scenarios and understand projected climate changes.
5. Assess risks and vulnerabilities : apply the selected risk assessment methodology to identify potential impacts, thier likelihood and consequences. Focus on critical safety and operational risks.
6. Develop and pioritize adaptation actions: develop a Climate Adaptation Plan, prioritizing actions based on criticality and available resources.
7. Review and update the assessment and plan: periodically assess, allowing for flexibility as the extent and timing of impacts evolves.

[4] *See the resources page for an indication of the guidance available*
https://www.eurocontrol.int/sites/default/files/2024-11/eurocontrol-factsheet-adapting-aviation-changing-climate-resources-list.pdf

Acknowledgements

This guide was developed by the European Aviation Climate Adaptation Working Group. EUROCONTROL and ACI Europe would like to thank all experts who contributed to its development.

SUPPORTING
EUROPEAN
AVIATION

www.eurocontrol.int