Weather and climate resilience: a short-term and long-term perspective for European aviation

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MOWE-IT Regional Conference, Berlin, 09 September 2014
CG13 Climate Change Risk and Resilience Task

Objectives:

Is climate change a risk for European aviation?
Do we need to take action?
What, when, where and whom?
## Key risks by impact area

<table>
<thead>
<tr>
<th>Climate Impact</th>
<th>Impact Area</th>
<th>En-route</th>
<th>airport operations</th>
<th>airport infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation change</td>
<td>disruption to operations e.g. airfield flooding, ground subsidence, reduction in airport throughput</td>
<td>drainage system capacity inundation of underground infrastructure e.g. electrical inundation of ground surface access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature change</td>
<td>Changes in performance / noise impact</td>
<td>heat damage to airport surface (runway, taxiway) increased heating and cooling requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea-level rise</td>
<td>Impact on en-route capacity due to loss of ground capacity</td>
<td>loss of airport capacity</td>
<td>loss of airport infrastructure</td>
<td></td>
</tr>
<tr>
<td>Wind changes</td>
<td>convective weather: disruption to operations, route extensions jet stream: increase in en-route turbulence</td>
<td>convective weather: disruption to operations local wind patterns: disruption to operations, changes to distribution of noise impact</td>
<td>damage to infrastructure</td>
<td></td>
</tr>
<tr>
<td>Extreme events</td>
<td>disruption to operations, route extensions</td>
<td>disruption to operations</td>
<td>damage to infrastructure</td>
<td></td>
</tr>
</tbody>
</table>

Source: based on ACI-EUROPE, AEN, DGAC, EUROCONTROL, LHR, MMU, NATS (2014, forthcoming)
Growth and adaptation: a double challenge

Projected changes in annual near-surface temperature 2021-2050 (relative 1961-1990 mean)

Projected changes in annual precipitation 2021-2050 (relative 1961-1990 mean)
So, are we prepared?

Two-stage stakeholder consultation:

**Survey Objectives:**

**Stage 1: Survey**

*Operational stakeholders: ANSPs, airport operators, aircraft operators, industry associations, CAAs*  
What does the European aviation sector think?  
Might climate change affect its business and operations?  
Should we consider taking measures to adapt?  
What actions and initiatives are planned or underway?

**Stage 2: Workshop**

*Operational stakeholders, decision-makers, research community*
Survey Parameters

1st October to 21 November 2012

35% response rate
All climate zones covered
Does your organisation…..

expect the impacts of climate change to affect its business between now and 2050?

It is not the task of my organisation
Risk/opportunity not yet assessed
Not yet on the long-term agenda.

consider adaptation actions to reduce the potential impacts of climate change may be necessary now or in the future?

Do not expect climate change to cause us any significant impacts
Risk/Opportunity not yet assessed

begun planning for adaptation to climate change impacts?

Too early
Do not have information
Do not have financial resources
Not aware of need
Barriers to adaptation

“Obstacles that can be overcome with concerted effort, creative management, change of thinking, prioritization, and related shifts in resources, land uses, institutions, etc.” Moser and Ekstrom 2010, p.22026

<table>
<thead>
<tr>
<th>Information barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of information and guidance</td>
</tr>
<tr>
<td>Risk assessment not carried out</td>
</tr>
<tr>
<td>Not aware that need to take action</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>National barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource constraints</td>
</tr>
<tr>
<td>Lack of established strategy</td>
</tr>
<tr>
<td>Difficulty to take action</td>
</tr>
</tbody>
</table>

Guidebook for Enhancing Resilience of European Air Traffic in Extreme Weather Events
Challenge: Climate Resilence

**Solutions:** integrate resilience to climate change as routine part of operational and business planning

- Identify risks and vulnerabilities (regional, network, local)
- Identification/implementation of local and network resilience measures
- Build resilience into *current* infrastructure and operations planning.
- No-regrets measures (e.g. SESAR OIs)
- Cost-effective measures (e.g. training)
- Increased collaboration with MET (advanced forecasting techniques)

*Early action is cost-effective*
London Heathrow Climate Adaptation Plan

Study followed 6 steps

1. Model future climate
2. Best practice review
3. Gathering evidence base
4. Risk assessment and adaptation response
5. Report
6. Implement and assure delivery
## Example Results

<table>
<thead>
<tr>
<th>Risk ID</th>
<th>Risk</th>
<th>Climate Variable</th>
<th>Threshold</th>
<th>Confidence (climate projections and or consequences)</th>
<th>Risk Grading (no adaptation)</th>
<th>Adaptation Response Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Temp</td>
<td>H</td>
<td></td>
<td>A</td>
<td>Prepare: Research into spill clean up options currently used at airports in warmer climates to commence to develop policies robust to air temperatures exceeding 38°C.</td>
</tr>
</tbody>
</table>
What is EUROCONTROL doing?

NM

- Survey of Weather Risk
- Developing ways to Alert the Network to Severe weather.
- Anticipation of severe weather provides the time to develop a managed response
Average Daily traffic

Average daily traffic for last 5 Years

- 2010
- 2011
- 2012
- 2013
- 2014
Delay causes

**Percentage of delayed flights: ATFM & All Causes**

- **% of flights delayed on departure:** - ATFM DNMs
- **% of flights delayed on departure:** - All Causes

- Green: > 15min by ATFM Restrictions (NM)
- Yellow: > 30min by ATFM Restrictions (NM)
- Purple: > 15min: All Causes (CODA)
- Pink: > 30min: All Causes (CODA)
Weather impact on ATFM delay

Year-to-date ATFM delays

- ATC Capacity
- Weather
- Industrial Action (ATC)
- Aerodrome Capacity
- ATC Staffing
- Other
- Special Event
- Equipment (ATC)
- Airspace Management
- Environmental Issues
- Equipment (non-ATC)
- ATC Routeing
- Accident/Incident
- Industrial Action (non-ATC)
- Not regulated/Not specified
- De-icing
Average daily ATFM delay
Delay locations

Top 20 delay locations for year-to-date en-route ATFM delays

- Marseille ACC: 2156 delays
-Warszawa ACC: 2069 delays
-Nicosia ACC: 1945 delays
-Brest UA CC: 1765 delays
-Reims UA CC: 1364 delays
-Karlovy Vary ACC: 1174 delays
-Maastricht UAC: 1114 delays
-Barcelona ACC: 991 delays
-Langen ACC: 860 delays
-ATHINAI CONTROL: 730 delays
-Paris ALL ACC: 704 delays
-Zagreb ACC: 527 delays
-Bordeaux ALL ACC: 526 delays
-Ankara ACC: 365 delays
-Canaries ACC/FIC: 346 delays
-Lisbon ACC: 290 delays
-London ACC: 282 delays
-Madrid All ACC: 231 delays
-Sternad Acc (245-): 211 delays
-Bratislava ACC: 192 delays

Top 20 delay locations for year-to-date Airport ATFM delays

- London Heathrow: 1168 delays
- Zurich: 982 delays
- Istanbul Atatürk: 824 delays
- Amsterdam Schiphol: 821 delays
- Frankfurt Main: 805 delays
- Stansted/Sabieha: 560 delays
- Geneva: 384 delays
- Wien Schwechat: 307 delays
- Palma de Mallorca: 287 delays
- Paris: 286 delays
- Copenhagen: 255 delays
- Brussels National: 239 delays
- London/Gatwick: 220 delays
- Munich: 207 delays
- Ralia (Nikosia): 190 delays
- Paris Charles de Gaulle: 169 delays
- Pisa San Giusto: 144 delays
- Mykonos: 139 delays
- Chania Ioannis: 134 delays
- Barcelona El Prat: 125 delays
The Network WX Resilience Roadmap

Each good management starts with anticipation...

SCOPE: WX RISK ASSESSMENT PROJECT

3d Information
- Nat Hazards
- WX Forecast
- WX Nowcast

Translation:
- Thresholds
- Constraints
- Capacity Risks

Impact Assessment
- Actual Demand
- Actual Resources
- Configurations

Decision Making
- Options
- Simulation
- Execution
- Monitoring

70% likelihood for 45 knots wind at 3000ft at EDDF

High Risk of Capacity Reduction by 20%

Current RWY configuration and resources – 5% reduction

Can be accommodated without regulation
The Architecture of the tool

- Natural Hazards Information
- Weather Forecast
-Probability Models
- Risk Assessment Models
- Impact Models

- EUROCONTROL NM and Other Stakeholders Consultation
- Interface for NOP Integration
- Text Outputs
- Stand Alone HMI Display

- Volcanic Ash Hazard Valid 052114
  Risk High

- Print

Valid Time: 10-Oct-2013 16Z
Last Update: 10-Oct-2013 12Z
Next Update: 10-Oct-2013 18Z

Medium Risk
Medium Risk
High Risk
High Risk
## Capacity Reduction

- Tables for each hazard and each airspace resource
- Performance reduction for each resource

### Capacity Reduction: Generic Airport

<table>
<thead>
<tr>
<th>Aeronautical Visibility (m)</th>
<th>Cal IIIC (RVR&lt;50)</th>
<th>Cat IIIB (RVR&lt;200)</th>
<th>Cat IIIA (RVR&lt;350)</th>
<th>Cat II (RVR&lt;550)</th>
<th>ICAO Visibility condition 2*</th>
<th>IMC</th>
<th>VMC</th>
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<tr>
<td>Ceiling (ft)</td>
<td>&lt;50</td>
<td>&lt;200</td>
<td>&lt;350</td>
<td>&lt;800</td>
<td>&lt;1500</td>
<td>&lt;5000</td>
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<td>Cat IIIB</td>
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<td>40%</td>
<td>15%</td>
<td>5%</td>
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</table>

Each cell contains performance reduction estimates (0 – 100%) provided by EUROCONTROL experts.
Numerical forecast model

- 6 hours refresh rate, starting at 0100 Z
- 48 hours (at least) look-ahead horizon
- Hourly temporal resolution
Weather Resilience: Table view

<table>
<thead>
<tr>
<th>ACC</th>
<th>Sector</th>
<th>Net Risk Score</th>
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</tbody>
</table>
Weather Resilience: Map View

Network Weather Resilience, v8.0

Map Filters

Meteorological
- Ceiling and Visibility
- En Route Convection
- Surface Winds
- Terminal Convection
- Winds at 3000 feet
- Winter Weather

Natural
- Chemical Dispersion
- Earthquake
- Fire
- Flooding
- Nuclear Emissions
- Space Weather
- Volcanic Ash

Attitude: FL3 - FL450

Map Overlays
- Airports
- Sectors FL340

Valid Time: 5-9-2014 8:00 UTC

Time Slider: Hour 1
5-9-2014 6:00 UTC 7-9-2014 7:00 UTC
18 months later…

- Some stakeholders carrying out risk assessments. *But* others are not yet ready to move….

- Uncertainties remain: changes in demand; noise distribution; quantification of impacts.

- What do we need? Metrics, guidance, tool kit?
Conclusions

• Diverse range of potential climate impacts identified
• Many organisations are not yet considering this risk
• Local and network resilience is required
• Build awareness/support to address barriers to action
• Identify no-regrets and cost-effective measures
• EUROCONTROL NM: already building weather resilience
• Early action is the key to cost-effective resilience

Thank you for your attention

Questions?