IMPACT OF CLIMATE CHANGE ON AVIATION VULNERABILITY

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INAIR Conference
Bratislava, November 8th 2013
Extreme weather – an aviation perspective

Passengers stranded at airport for two days as airlines cancel flights due to big freeze (01/18/2013)

Heathrow airport all but shut as snow hits Christmas travel plans (12/20/2010)

Europe Snow Storm Closes Airports: London Heathrow Closed Until Sunday (12/18/2010)

Near-Crash in Hamburg: Investigators Criticize Airbus for Inadequate Pilot Manuals (03/04/2010)
Outline

- Definition of vulnerability in the ATM context
- METAR weather codes by the ATM Performance Group (ATMAP)
- Severe weather impacts on the ATM
  - Single airport (local view)
  - ATM European network (regional view)
- Interdependencies of traffic conditions at airports and severe weather impacts
- Conclusions
State of ATM System*

Uncertainties:
- type, frequency, intensity, duration and time of occurrence

Modification of system
- lethal stress

Uncertainty:
- type of stress

ATM-System

Uncertainty:
- type of perturbation

survival stress

- permanent perturbation
- transient perturbation

Robustness of system
- no stress

New reference state of system

Resilience of system

*as defined in (Gluchshenko 2012)
Eurocontrol ATM Airport Performance (ATMAP) – Group
Severity Classes assigned to METAR weather codes

- METAR is a message containing all safety critical meteorological observations for flight operations in a given airport and nearby airspace (up to 16km from the airport)

- ATMAP weather algorithm* assigns severity coefficients to the following weather classes (the higher the coefficient the more severe the weather event)
  - Visibility and Ceiling
  - Wind
  - Precipitations
  - Freezing conditions
  - Dangerous phenomena

- En-Route weather events are not covered by METAR descriptions

*Eurocontrol Technical Note: Algorithm to describe weather conditions at European airports – ATMAP weather algorithm Version 2.3, May 2011
## Elements of ATMAP-weather classes with high coefficients

<table>
<thead>
<tr>
<th>Weather Class</th>
<th>Ceiling and visibility</th>
<th>Wind</th>
<th>Precipitations</th>
<th>Freezing conditions</th>
<th>Dangerous phenomena</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>„Low visibility“ operations; ILS separation minima increased</td>
<td>Impact on aircraft over ground speed; crosswind threshold</td>
<td>Substantial equipment, complex procedures required</td>
<td>Heavy frost conditions even for Scandinavia</td>
<td>Dangerous for safety of aircraft operations, unpredictable impact</td>
</tr>
<tr>
<td><strong>Condition</strong></td>
<td>Approach CAT II - III</td>
<td>Wind speed &gt; 30 kts</td>
<td>FZxx, (+)SN</td>
<td>[T &gt; 3° C and (+)(SH)SN, FZxxx] OR [T&lt;= -15° C with visible moisture]</td>
<td>[TCU, CB and cloud cover] [TCU, CB and cloud cover and (+/-) SHxx] [GS, FC, DS, SS, VA, SA, GR, PL, TS, +TS]</td>
</tr>
<tr>
<td><strong>Coefficient</strong></td>
<td>4-5</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>[3-12] [4-24] [18-24]</td>
</tr>
</tbody>
</table>
Severe weather impact on aviation industry (1)

Disruptions due to thunderstorms at late evening
planned and actual movements - (May 2008)
Coefficient: 2,69
Severe weather impact on aviation industry (2)

Disruptions due to fog in the morning hours
- Planned and actual movements - (October 2008)
Coefficient: 0.59
Severe weather impact on aviation industry (3)

Disruptions due to low snow fall in the morning hours, heavy snowfall and low visibility in the afternoon
Planned and actual movements - (March 2006)
Coefficient: 4.74
Traffic over Europe, 2006-06-15
Kyrill: Comparison of travel times at European airports:
(Arrivals, ASMA 100 NM)

Travel time: Consequences from Kyrill

Source: EUROCONTROL DDR-Data
Network effects

Weather disturbance reports over a wide area and arrival punctuality at a selected airport (Winter 06/07 und 07/08)
Interdependencies of traffic conditions at airports and severe weather impacts

<table>
<thead>
<tr>
<th>Weather Impact</th>
<th>WEATHER IMPACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderate fog, wind, rain</td>
<td>long-lasting heavy snow falls, freezing precipitations</td>
</tr>
<tr>
<td>light</td>
<td>Great disturbances at any airport including possible complete shutdown. Runways need to be removed. Dependent on airport equipment.</td>
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<tr>
<td></td>
<td>Delays, cancellations, partly airport closure, knock-on effects</td>
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<td></td>
<td>Airport operations in a reduced mode even though weather conditions have improved within the same day.</td>
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<tr>
<td>Traffic</td>
<td></td>
</tr>
<tr>
<td>congested</td>
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<tr>
<td></td>
<td>Separation of aircraft has to be increased, runway conditions as well as braking action are decreased.</td>
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<tr>
<td></td>
<td>Delays</td>
</tr>
<tr>
<td></td>
<td>Returning back to the reference point within the same day is feasible.</td>
</tr>
<tr>
<td></td>
<td>Great disturbances. E.g. multiple runway systems need to be removed from snow alternately.</td>
</tr>
<tr>
<td></td>
<td>Delays, cancellations, partly airport closure, knock-on effects</td>
</tr>
<tr>
<td></td>
<td>Airport operations in a reduced mode even though weather conditions have improved. Recovery to normal operations can take several days to complete.</td>
</tr>
</tbody>
</table>

LEGEND
- robustness
- resilience
- new reference state
Conclusions

- Definition of the conditions vulnerability and resilience
- Classification of weather events according to the ATMAP group
- Overview of the impact of extreme weather events on the performance of the ATM system using local and regional traffic examples
- Interdependencies of traffic conditions at airports and severe weather impacts

Next step
- Vulnerability of airports depending on their demand and airside capacity ratio
Thank you for your attention!!!

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