Enhancing Resilience in European Air Traffic Passenger and Freight Transport

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Michael Kreuz

Mariana Bartsch
Partners

Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

Karlsruher Institut für Technologie

FINNISH METEOROLOGICAL INSTITUTE

CYPRUS METEOROLOGICAL SERVICE
Extreme weather events – an aviation perspective

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

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

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

Heat waves gripping Northeast (07/06/2010)
Outline

- Expected future weather conditions over Europe
- Definition of the vulnerability of the ATM System
- Aspects of Resilience
- Examples of extreme weather impact on the aviation system
- Impacts on air cargo and supply chains
- Recommendations
Expected future weather conditions over Europe

- **Northern Europe**
  - Temperature rise larger than European average
  - Increased winter storm risk
  - Reduction in ground frost depth and duration
  - Increase in winter precipitation
  - Reduction in snow cover but potential heavier snow events

- **North-Western Europe**
  - Increase in winter precipitation
  - Increased winter storm risk
  - Increased flood risk in coastal areas
  - Increased spring floods

- **Coastal zones**
  - Sea level rise
  - More frequent and more intense storms

- **Mediterranean region**
  - Temperature rise larger than European average
  - Increase in annual precipitation
  - Increased in warm temperature extremes

- **Central and eastern Europe**
  - Increase in warm temperature extremes
  - Decrease in summer precipitation
  - Reduction in cold spells and snow

- **Mountain regions**
  - Temperature rise larger than European Average
  - Reduced snow cover

**Impact**
Determination of impacts on ATM System*

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

Uncertainty:
type of stress

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

Vulnerability

- System Modification
  - lethal stress
- New Reference State
  - permanent perturbation
- Resilience
  - transient perturbation

Robustness

*as defined in Gluchshenko, O. (2013) ‘Performance based approach to investigate resilience and robustness of the ATM system’, ATM Seminar 2013, Chicago
Impacts on Resilience

(Extreme) Weather Conditions

Resilience

Operational ATM Reaction Patterns

ATM Capacity
Extreme weather events and their impact

- Fog
- Heavy Precipitation
- Lightning
- Hail
- Snow Icing
- Wind
- Turbulence
- Tornado
- Sand Storm
- Heat Waves

Operational Reaction Pattern

- Increased Aircraft Separation
- Operating Restrictions Aircraft / Airports
- Runway Closure
- Airspace Closure
- Airport Closure
- Increased Break Times
- Staffing

Constraints on Outdoor Activities

- Reduced Aircraft Performance
- Reduced Visual Recognition
- Slipperiness
- Airport Damage
- Aircraft Damage
- Reduced Operational Infrastructure

Operational ATM Reaction Pattern

Severity
Impact of disturbances - Characteristics of the system

Flow-Delay Curve

High Demand

Demand after temp. closure

Low Demand

Demand after temp. closure

Average delay [min/AC]

Resulting delay

Resulting delay

Flow [AC/h]
Severe weather impact on aviation industry (1)

Disruptions due to thunderstorms at late evening planned and real movements - May 2008
Coefficient: 2.69*

*N.B., Coefficient of 2.69 refers to the definition of bad weather days according to the ATMAP weather algorithm*

A Bad weather day is defined as: Coefficient > 1.5

*as defined in EUROCONTROL (2011) ‘Algorithm to describe weather conditions at European airports’, May 2013
Severe weather impact on aviation industry (2)

Disruptions due to low snow fall in the morning hours, heavy snowfall and low visibility in the afternoon
Planned and real movements - March 2006
Coefficient: 4.74
ASMA Travel time: Consequences from winter storm Kyrill

Comparison of travel times at European hub airports (approaches, ASMA 100 NM)

European Airports

- Frankfurt
- L.-Heathrow
- Amsterdam
- Cologne
- Manchester
- L.-Gatwick
- Dusseldorf
- Munich
- Zurich
- Hamburg
- L.-Stansted
- Paris ORY
- Gent
- Paris CDG
- Dublin
- Brussels
- Prague

Source: EUROCONTROL DDR-Data
Network Effects (1)

- Definition of airports with relevant number of city-pairs to the selected airport
- Analysis of the correlation of weather disturbance reports at these airports with the arrival punctuality at the selected airports
Network Effects (2)

Wind disturbance report over a wide area and arrival punctuality at a selected airport (Winter 06/07 and 07/08)
Identified Impacts on Air Cargo

- Closure of airspace
- Closure of airports
- Over-flight constraints
- Cancellation of flights
- Rerouting
- Delays
- Interruptions of supply chains
- Non-delivery of goods
- Stop of just in time productions
- Employees on unpaid leave

### Eruption of Eyjafjallajökull, Iceland 2010 - Percentage of cancelled flight in EU 27

<table>
<thead>
<tr>
<th>Including Overflights</th>
<th>15APR</th>
<th>16APR</th>
<th>17APR</th>
<th>18APR</th>
<th>19APR</th>
<th>20APR</th>
<th>21APR</th>
<th>22APR</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(% 'cancelled' flights)</td>
<td>All-Cargo</td>
<td>29%</td>
<td>64%</td>
<td>78%</td>
<td>82%</td>
<td>67%</td>
<td>49%</td>
<td>15%</td>
<td>3%</td>
</tr>
</tbody>
</table>

Evaluation of Historic Weather Events

- **Case studies on volcanic eruptions**
  - Eyjafjöujökull, Iceland 2010
  - Mount Redoubt, Alaska USA 2009

- **Case studies on storms**
  - Hurricane Sandy, USA 2012
  - Winter storm in Europe 2010
Response and adaption strategies I

- Main response actors: airlines, airports and airspace control institutions

- Identified measures often reactive

- Detailed forecasts of weather events necessary

- Information is spread via traditional media channels and social media

- Close cooperation of EUROCONTROL and national air navigation service providers

- Cooperation with other modes of transport, e.g. rail or road
  - If this modes of transport are not affected themselves
Response and adaption strategies II

After the eruption of the Eyjafjoujökull the European Commission:

- decides to form a group of experts to identify and establish techniques and methods that can be used if similar eruptions occur

- Accelerated the implementation of a Single European Sky (SES) initiative
  - Grouping of nation-wide competencies to coordinate the European response on incidents
Findings

- In Europe the **most cargo is transported via road**
  - Non-affection of supply of consumer goods e.g. during the winter storm in Europe 2010

- Air cargo is **often transported with passenger flights**
  - data availability for solely air cargo is rare

- For many goods are **sufficient stocks** available
Interdependencies of traffic conditions at airports and severe weather impacts

Weather Impact

- moderate fog, wind, rain
  - Increase of aircraft separation
  - Decrease of braking action
  - Delay
  - Return back to regular operations is feasible within the same day

- long-lasting snow falls, heavy precipitation
  - Airport operations in a reduced mode despite improved weather conditions within the same day
  - Significant disturbances including possible complete shutdown
  - Delays, cancellations, partly airport closure, knock-on effects
  - Airport operations in a reduced mode
    - Recovery to regular operations can take several days
  - Airport operations in a reduced mode
    - Recovery to regular operations can take several days

Demand

- low
- high

Robustness

Resilience

New Reference State
Recommendations for international policy

- Research efforts shall be encouraged to understand the network situation and the propagation of delays
- Performance measurement system shall be developed to assess the system’s behavior in different scenarios under changing climate conditions
- Higher transparency in the comparison of the impacts of disruptive events shall be fostered to overcome today’s imprecision in defining and assigning IATA delay codes and their statistical evaluation procedures
Recommendations for the aviation sector

- Aspects of climate change shall be taken into account in **ATM Master Plans**

- The inter-airline and intermodal cooperation shall be enhanced to **mitigate the impact on travelers** in case of extreme weather events

- **Cooperation of ATM stakeholder** (airports, airlines, air navigation service provider) shall be enhanced to identify disruptive events and learn from best practices
Recommendations for research and technical development

- Activities to improve local weather and disruption forecasts shall be continued
- Inter-airline and intermodal cooperation shall be enhanced, e.g. through the generation of a new ticket category with increased flexibility
- Passenger and weather information services shall be developed to bring passengers into a more active role
- Assessment if and how shifts in traffic flows relocate disruptive problems or even may generate new disruptions
Contact Details

German Aerospace Center
Institute of Flight Guidance
Lilienthalplatz 7
38108 Germany

Michael Kreuz | Project MOWE-IT
michael.kreuz@dlr.de
+49 531 295 2840

Dr. Annette Temme | Project MOWE-IT
annette.temme@dlr.de
+49 531 295 3006

Karlsruhe Institute of Technology
Institute for Industrial Production (IIP)
Hertzstraße 16
76187 Karlsruhe

Mariana Bartsch | Project MOWE-IT
mariana.bartsch@kit.edu
+49 721 608 44463