Impact of Bird Strikes on ATM Processes

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Overview

- **Goal**: analyse operational impacts caused by bird strikes
- **Method**: literature, interviews, questionnaires, visits
- **Result**: three-level model including probabilities
Model Overview I

1st level: phases of flight

- en-route
- approach
- landing
- taxiing
- turn around
- taxiing
- departure

2nd level: scenarios

- no disruption
- go-around
- taxiing
- disabled aircraft
- disabled aircraft
- taxiing
- disabled aircraft
- taxiing
- disabled aircraft
- return
- return
- return
### Model Overview II

#### 3rd level: stakeholder processes

<table>
<thead>
<tr>
<th>Aircraft operator</th>
<th>Airport</th>
<th>ATC</th>
</tr>
</thead>
<tbody>
<tr>
<td>cockpit decision process</td>
<td>runway inspection</td>
<td>go-around process</td>
</tr>
<tr>
<td>Aircraft on Ground (AOG) process</td>
<td>apron control disruption process</td>
<td>ground ATCO process</td>
</tr>
<tr>
<td></td>
<td>airport duty management disruption process</td>
<td>runway blockage process tower ATCO</td>
</tr>
<tr>
<td></td>
<td>bird repelling</td>
<td>runway blockage approach ATCO</td>
</tr>
<tr>
<td></td>
<td>emergency services ground alert</td>
<td>emergency/mayday</td>
</tr>
<tr>
<td></td>
<td>emergency services airborne/inbound alert</td>
<td></td>
</tr>
</tbody>
</table>
Example Scenario: Return

1st level: phases of flight
- en-route
- approach
- landing
- taxiing
- turn around
- taxiing
- T/O > V₁
- departure
- T/O ≤ V₁

2nd level: scenarios
- return
- no disruption
- go around
- taxiing
disabled aircraft
disabled aircraft
taxiing
disabled aircraft
taxiing
taxiing
disabled aircraft
disabled aircraft
Example Scenario: Return

1. Bird strike
   - 0 min

2. Bird damages A/C
   - 0 min

3. A/C shows anomalies
   - 0 min

4. Yes
   - 3-10 min

5. Takeoff/climb continues

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**Cockpit**

- Anomalies not acceptable
  - 0-5 min

- Return, diversion
  - 0 min

- Information
  - 1 min

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**Flight Operations**

- Precautionary/emergency landing
  - 0 min

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**Maintenance Operations**

- Holding, assess situation
  - 10-30 min

- Burn off/dump fuel
  - 0 min to 3 h

- Position for approach
  - 5-20 min

- Landing

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**2nd level: scenarios**
Example Scenario: Return

3rd level: stakeholder processes

airline

ATC

airport
Example Scenario: Return

A/C disabled on runway

0 min

Apron Control

coordinates traffic

organizes and coordinates

Ground Handling

tow truck

total: av 5 min

airport

inspection
Example Scenario: Return

3rd level: stakeholder processes
Overview: Scenarios and Processes

<table>
<thead>
<tr>
<th>scenarios</th>
<th>processes</th>
<th>response times</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>63</td>
<td>163</td>
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</tbody>
</table>
Example Scenario: Return Probability of Occurrence

- bird strikes reports:
  - number of bird strikes
  - impact on operations

- traffic data
  - 5.4 mio aircraft movements per year

<table>
<thead>
<tr>
<th>year</th>
<th>bird strikes</th>
<th>bird strikes during take-off, climb, cruise</th>
<th>percentage in %</th>
<th>unscheduled landings</th>
<th>percentage in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1722</td>
<td>456</td>
<td>26,5</td>
<td>48</td>
<td>10,5</td>
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<td>2011</td>
<td>1577</td>
<td>576</td>
<td>36,5</td>
<td>20</td>
<td>3,4</td>
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<td>2012</td>
<td>1586</td>
<td>591</td>
<td>37,2</td>
<td>47</td>
<td>8,0</td>
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<td>2013</td>
<td>1606</td>
<td>567</td>
<td>35,3</td>
<td>85</td>
<td>15,0</td>
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<td>2014</td>
<td>1816</td>
<td>614</td>
<td>33,8</td>
<td>64</td>
<td>10,4</td>
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<tr>
<td>Ø/a</td>
<td>1661</td>
<td>561</td>
<td>33,8</td>
<td>53</td>
<td>9,5</td>
</tr>
</tbody>
</table>

\[ P(x) = 9,8 \cdot 10^{-6} \] per aircraft movement
Probability of Occurrence for other scenarios

- **return**
- **go around**
- **taxiing**
- **disabled aircraft**
- **no disruptions**

**Probabilities:**
- return: 9.8 x 10^{-6}
- go around: no data
- taxiing: 4.4 x 10^{-6}
- disabled aircraft: 1.3 x 10^{-6}
- no disruptions: 2.7 x 10^{-4}

**Legend:**
- STOP
- **no data**
Risk Assessment: Disruption Potential

**Return**
- AL: 15 min
- APT: 8 min
- ATC: 8 min

**Go Around**
- AL: 15 min
- APT: 8 min
- ATC: 8 min

**Taxiing**
- AL: 15 min
- APT: 8 min
- ATC: 8 min

**Disabled Aircraft**
- AL: 40 min
- APT: 23-110 min
- ATC: 0-110 min

**Stop**
- AL: 9 min
- APT: 8 min + landing
- ATC: 19 min

**AL: 15 min**
- APT: 0-8 min
- ATC: 0-8 min

**APT: 8 min**
- APT: 8 min
- ATC: 8 min

**ATC: 8 min**
- APT: 8 min
- ATC: 8 min

**AL: 47 min**
- APT: 23-110 min
- ATC: 0-110 min

**AL: 40 min**
- APT: 18-86 min
- ATC: 18-86 min

**AL: 18-86 min**
- APT: 0-8 min
- ATC: 0-8 min

**AL: 38 min**
- APT: 18-86 min
- ATC: 18-86 min

**AL: 30 min**
- APT: 18-86 min
- ATC: 18-86 min

**AL: 38 min**
- APT: 18-86 min
- ATC: 18-86 min

**AL: 40 min**
- APT: 18-86 min
- ATC: 18-86 min

**AL: 40 min**
- APT: 18-86 min
- ATC: 18-86 min

**AL: 47 min**
- APT: 23-110 min
- ATC: 0-110 min

**AL: 40 min**
- APT: 18-86 min
- ATC: 18-86 min

**AL: 47 min**
- APT: 23-110 min
- ATC: 0-110 min

**AL: 40 min**
- APT: 18-86 min
- ATC: 18-86 min

**AL: 40 min**
- APT: 18-86 min
- ATC: 18-86 min

AL: airline
APT: airport
ATC: air traffic control
Conclusions

**this work**
- generic three-level model
- scenario probabilities
- process times

for the airport stakeholders

**potential future work**
- cascade effects
- monetary aspect
- other disruption causes
Conclusions

this work

- generic three-level model
- scenario probabilities
- process times

for the airport stakeholders

potential future work

- cascade effects
- monetary aspect
- other disruption causes

Thank you!

Questions?
birds on/near runway

Wildlife Control

av 5 min
dispatches on site

av 10 min
perform repelling actions

ADM

1 min
when finished: informs

1 min
Tower Control

total: av 17 min