Airport Resiliency: Preparing for the Future

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MINNESOTA AIRPORTS CONFERENCE
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Resilience and Adaptation Defined

» “Capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.”

Source: Airports Council International - North America’s (ACI-NA)
Temperatures are Rising and Projected to Continue to Rise

» MN Since 1970
- Winter has warmed 13 times faster than summer
- Nights have warmed 55% faster than days
- Frequencies of -35°F readings in north MN and -25°F readings in the south have fallen by up to 90%
Precipitation Depth and Intensity is Increasing

» Heavy Rains
  – More intense than at any time on record.
  – Long-term observation sites have seen dramatic increases in 1-inch, 3-inch rains, and heaviest rains.
  – Projections indicate more big rains into the future.

Source: ©2007 NBC Universal, Inc
Winter Temperatures Changing Deicing Operations

- More Transitional Precipitation (wet snow, ice, freezing rain)
  - More Aircraft Deicer Applied
  - More Pavement Deicer Applied
Other Expected Weather Changes

**CLIMATE VECTOR CHANGES FROM 2010 TO 2060: DULUTH, MN**

<table>
<thead>
<tr>
<th>Climate Vector</th>
<th>Confidence</th>
<th>% Increase/Decrease</th>
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</thead>
<tbody>
<tr>
<td>Dry Days</td>
<td>Moderate</td>
<td>&lt;1 increase</td>
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<tr>
<td>Freezing Days</td>
<td>High</td>
<td>41% decrease</td>
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<tr>
<td>Frost Days</td>
<td>High</td>
<td>18% decrease</td>
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<tr>
<td>Heavy Rain (1 Day)</td>
<td>Low</td>
<td>24% increase</td>
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<tr>
<td>Heavy Rain (5 Day)</td>
<td>Low</td>
<td>11% increase</td>
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<tr>
<td>Hot Days</td>
<td>High</td>
<td>&gt;500% increase</td>
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<tr>
<td>Hot Nights</td>
<td>High</td>
<td>&gt;400% increase</td>
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<tr>
<td>Humid Days</td>
<td>High</td>
<td>&gt;300% increase</td>
</tr>
<tr>
<td>Snow Days</td>
<td>Moderate</td>
<td>20% decrease</td>
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<tr>
<td>Storm Days</td>
<td>Low</td>
<td>6% increase</td>
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<tr>
<td>Very Hot Days</td>
<td>High</td>
<td>800% increase</td>
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<tr>
<td>Cooling Days</td>
<td>High</td>
<td>34% increase</td>
</tr>
<tr>
<td>Heating Days</td>
<td>High</td>
<td>10% decrease</td>
</tr>
<tr>
<td>Cooling Degree Day (CDD)</td>
<td>High</td>
<td>&gt;200% increase</td>
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<tr>
<td>Heating Degree Days (HDD)</td>
<td>High</td>
<td>18% decrease</td>
</tr>
</tbody>
</table>

Source: ACROS, 2018, Prepared by: RS&H, 2019
### Infrastructure Vulnerabilities

<table>
<thead>
<tr>
<th>Access Roads</th>
<th>Aircraft Fuel Storage / Fueling</th>
<th>Commercial Passenger Terminal Facilities</th>
<th>Environmental (Noise, Air Quality, Water Quality and Quantity)</th>
<th>Regional Infrastructure</th>
<th>Runways, Taxiways, and Holding Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Road Flooding</td>
<td>Jet Fuel System Valves, Pumping and Controls Equipment Located in Underground Vaults on the Ramp</td>
<td>Damage from Direct Lightning Strikes and Hail</td>
<td>Changes to Concentrations and Volumes of Runoff Alter Stormwater Compliance</td>
<td>Demand for Evacuation</td>
<td>Debris and Foreign Object Damage</td>
</tr>
<tr>
<td>Erosion and Undermining, Damage of Pavement</td>
<td>Become Submerged and Potentially Inoperable</td>
<td>Failure of Building Envelope (Roofing Materials, External Seals)/Mold Vulnerability</td>
<td>Changes to Ecosystem May Change Wetlands and Off Airport Mitigation Needs</td>
<td>Increased Economic Strain on the Airport</td>
<td>Erosion and Undermining of Pavement</td>
</tr>
<tr>
<td>Flooding of Tunnels</td>
<td>Lifting and Rupturing of Buoyant Underground Tanks</td>
<td>Increased HVAC Demand and Duration</td>
<td>Dryer Soils Leads to Reduced Vegetation, Erosion, Fire</td>
<td>Increased Need for Emergency Facilities</td>
<td></td>
</tr>
<tr>
<td>Thermal Expansion of Bridge Joints</td>
<td>Potential Increase In Fire Risks (Flashpoint of Aviation Fuel Is 100°F)</td>
<td>Passengers and Employees Stranded and/or Airport Used As An Area of Refuge</td>
<td>Increases in Invasive Species</td>
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<td>Reduced Water Availability Due to Drought</td>
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<td>Subsidence of Foundations</td>
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<td>Wind Damage</td>
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### Operational Vulnerabilities

#### Aircraft Performance
- Changes to Approach Routes
- Greater Turbulence
- High Winds Interfere with Landings and Takeoffs
- Increased Cooling Demand
- Reduced Climb Rates and Increased Power Demand
- Reduced Visibility Due to Heavy Precipitation

#### Bird and Wildlife Hazard Management
- Changes in Ecosystems and Distributions of Pests / Wildlife
- Increased Risk of Bird Strikes From Ecosystem Changes

#### Environmental (Noise, Air Quality, Water Quality and Quantity)
- More Stringent GHG Emission Reduction Standards
- Noise Complaints Due to Increased Thrust
- Ozone Pollution and Poor Air Quality

#### Personnel and Passengers
- Change in Tourism and Seasonal Enplanements
- Heat Exposure
- Human Migration
- Outbreak of Contagious Diseases
- Vector Borne Illness

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<thead>
<tr>
<th>Weather Phenomena</th>
<th>Aircraft Performance</th>
<th>Bird and Wildlife Hazard Management</th>
<th>Environmental (Noise, Air Quality, Water Quality and Quantity)</th>
<th>Personnel and Passengers</th>
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<tbody>
<tr>
<td>Increased Precipitation</td>
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<tr>
<td>Increased Temperatures</td>
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<tr>
<td>Rising Sea Level and Storm Surge</td>
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<tr>
<td>Thunderstorms</td>
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<tr>
<td>Microbursts, Typhoons</td>
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<td>Wildfires</td>
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</tbody>
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Airports Prepare for Challenges in Many Ways

- Strategic Plans
- Master Plans/Capital Plans
- Sustainability Management Plans
- Asset Management Systems
- Safety Management Systems
- Continuity of Operations Plans
- Emergency Response Plans
- ACRP Reports and Tools
Typical Time Horizons
ACI Resolution No. 3 (June 2018)

» Encouraging Airports to Take Action on Resilience and Adaptation to Climate Change, Resolves to:

- Consider all practicable steps to reduce their GHG emissions through the use of the Airport Carbon Accreditation programme and by other means;
- Support efforts in international forums such as ICAO and the UNFCCC in assessing the potential impacts of climate change on critical infrastructure, including airports;
- Encourage member airports to take into consideration the potential impact of climate change as they develop their Master Plans;
- Encourage member airports to conduct risk or criticality assessments for their operational procedures and existing infrastructure which considers the risks imposed by more adverse weather events and climate change;
- Encourage member airports to develop and incorporate actions in accordance with their risk or criticality assessments at an early stage and in line with their overall business continuity management and emergency planning; and
- Encourage member airports to plan and develop effective communication channels and collaborate with internal airport staff, aviation stakeholders, including airlines, ANSPs, communities and municipality authorities responsible for weather monitoring and disaster management.

ACI Briefing Note:  https://store.aci.aero/product/policy-brief-airports-resilience-and-adaptation-to-changing-climate/
Broad assessment approach

Step 1 – Identify Expected Climate Change Impacts
Step 2 – Inventory Infrastructure at Potential Risk
Step 3 – Inventory Operations at Potential Risk
Step 4 – Evaluate the Risks (SMS?)
Step 5 – Conduct Detailed Vulnerability Assessment
Step 6 – Identify Potential Mitigation Measures
Step 7 – Develop Implementation Plan
Triggers for Incorporating Adaptation

Respond to Event(s)

Incorporate Into Infrastructure Processes

Replacement, Expanded or New Infrastructure

Develop Resilient Operational Response Procedures

$1 in proactive planning/upgrades saves $4 to $6 in response/rebuilding costs
River Flood Wall
St Paul Downtown Airport, Minnesota, USA

» Frequent River Flooding

» Developed Removable Flood Wall Reducing Economic Losses

» Deployed 5 times in last 10 years
  – 3,600 ft (1000m) long
  – 8.5 ft (2.5m) high
PANYNJ Design Standard

» Assessed Infrastructure
  – Vulnerabilities
  – Risk
  – Adaptations

» Developed design guidelines
  – Temperature
  – Precipitation
  – Sea level
  – Flood

Incorporate Into Infrastructure Processes
Airport Runway Length Revisited

» Climate Risk: Current 2010 Temperature

» Airport Impact: Take-Off Runway Length Requirements

Example Airport Mean Max. Daily Temp of Hottest Month: 84°F (28.9°C)
Elevation: 1,000ft AMSL

Take-Off Requirement: 11,000 feet (3,352 meters)
Airport Runway Length Revisited

» **Climate Risk:** Future 2075 Temperature

» **Airport Impact:** Take-Off Runway Length Requirements

Example Airport Mean Max. Daily Temp of Hottest Month: **108°F (28.9 °C)**
Elevation: 1,000ft AMSL

Take-Off Requirement: **13,700 feet** * (4,175 meters)

*Must reduce maximum take-off weight!*

Incorporate Into Infrastructure Processes

B777-300ER
Broward County, FL
Predictions

- 2060-2069
- Precipitation depths
  - 9% increase
- Sea level rise
  - 2 to 3 feet (1 meter)
- Groundwater elevations rise
» Rising Groundwater Elevations
  – Compliance challenge
    • *Reducing stormwater storage and treatment capacity*
  – Significantly higher flood elevations
Available Alternatives

» Flood Impact
  – Fill above flood elevation
  – Flood proof structures

» Stormwater Impact
  – Lower groundwater
  – Pump storm water offsite for treatment
Hong Kong: Taking Control of Rapid Recovery from Adverse Weather

» Severe Events
  – Achieving rapid response and recovery

» Response
  – Ongoing coordination with local community on early warning system
  – Airport leading coordination
    • Assist with ground control
    • Coordinates with all stakeholders i.e., airlines, ground and ramp services agents, Government depts, public transport operators, retail and catering outlets in the terminal and passengers
Conclusions

» Each Airport and the Community It Serves is Unique

» Significant Challenges Ahead for Many Airports
  – Financial
  – Insurance
  – Regulatory

» Solutions Will be Found by Working Closely with All Stakeholders