The Future of Airports

A Vision of 2040 and 2070

Topic No. 8: Operational Performance and Resilience

White Paper

ENAC Alumni – Airport Think Tank

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Foreword

In February 2019, ENAC Alumni – the alumni association of the National University of Civil Aviation (ENAC) – organized a day of discussion and education on the current and future challenges in air transportation: **The State of the Air (“Les Etats de l'Air”)**. This event, held at the headquarter of the French General Directorate for Civil Aviation (DGAC), was part of a broader effort to fulfill some of our primary missions toward our 24,000 members: to maintain their knowledge up to date, to provide them platforms where to express and exchange ideas, and to promote excellence in aviation & space.

In addition to master classes on Airports, Aircraft and Systems, Design & Certification, Airline Operations, Air Traffic Management, Aircraft Maintenance, Pilots & Flight Operations, Safety & Compliance, and Entrepreneurship, **the State of the Air** featured a series of roundtables bringing together key leaders of the industry in the sectors of air transportation, tourism and general aviation who presented their vision of the future.

Following the large success of the State of the Air, and considering the dedication and expertise of our alumni, it has been decided to take the momentum and invite our think tanks to launch projects on the future of aviation. These think tanks reflect the diversity and excellence of our alumni community: air traffic management, airline operations, airports, digital innovation, and sustainable development.

The Airport Think Tank chaired by Gaël Le Bris is one of the most active of our research groups. The Future of Airports is an important study that brings a significant value added to help us foresee future challenges and prepare our industry for the changes to come. The participants of The Future of Airports have provided remarkable work. The output of the working sessions and the research findings are being released as white papers and other practice-ready materials that will be shared and brought to decision makers and leaders of both the public and private sectors worldwide. I am confident that the outcome of this Think Tank will be a huge move forward for the promotion and recognition of the ENAC Alumni.

Marc Houalla, President of ENAC Alumni

Introduction

From March 2019 to April 2020, the Airport Think Tank of ENAC Alumni conducted a research project on the long-term future of the airport industry: “The Future of Airports”. The project involved thought aviation leaders from diverse backgrounds and affiliations who looked at the trends and potentially disruptive changes, emerging transformational innovations, their impact on practice and their challenges for air transportation, and the needs in research, education, and policies for anticipating and facilitating these changes.

The future of airports cannot be envisioned without considering the future of our societies. At the 2040 and 2070 horizons of our study, we will count more fellow human beings than ever. Overall, we will be wealthier and more educated, and have a longer life expectancy. However, we will all face increased impacts from climate change that will put pressure on resources and communities, and might increase inequalities. We will have different social expectations. How can aviation address these new paradigms and continue to provide mobility?

First and foremost, we shall never forget that safety always comes first. As we are making air transportation increasingly automated and connected, we shall remember that our top priority must be to safeguard life, health, and property, and to promote the public welfare.

Human-induced climate change is the most formidable threat to our civilization. Transportation must become greener if we want to sustain the development of our societies without degrading our well-being and endangering public health at a horizon increasingly visible. Aviation shall keep pioneering green policies.

As aviation professionals, we are on the front line to tackle the fundamental issues arising and still continue to interconnect people and move freight. Aviation shall remain a world of opportunities and “create and preserve friendship and understanding among the nations and peoples of the world” as stated in the Convention of Chicago of 1947.

By 2040 and 2070, it is likely that unforeseeable groundbreaking technological innovations, scientific discoveries, and social and political changes will occur and deeply impact our world. When reading these pages, remember that we conducted our work and prepared these materials with our eyes of 2019.

We are all part of this future, and we can make a difference individually if we make ethical and sustainable decisions. Aviator and writer Antoine de Saint-Exupéry said that when it comes to the future, “it is not about foreseeing it, but about making it possible”. Let’s make a bright aviation future possible together.

Gaël Le Bris, Chair of the Airport Think Tank of ENAC Alumni

Topic No. 8: Operational Performance and Resilience

Airports and Aviation Systems are Increasingly Sensitive to Disruptions

Airports and aviation systems are complex ecosystems that support a global economy and provide for the safe and efficient movement of passengers and cargo. According to the Air Transport Action Group (ATAG), aviation supports 65.5 million jobs worldwide and enables 2.7 trillion USD[a] in global GDP.[1] In average, over 44,000 flights are controlled daily in the United States[2] and over 30,000 in Europe[b,3]. A significant disruption in the skies or at a single commercial service airport can rapidly cost millions USD to the society. A power outage at Hartsfield-Jackson Atlanta Intl. Airport (ATL) in December 2018 led to the cancellation of 1,400 flights and cost between 25 to 50 million USD to Delta Air Lines alone. Eurocontrol considers that the cost a flight cancellation ranges from 7,000 to 125,000 USD, including the passenger opportunity cost. The tactical (last-minute) delay to airlines can range from 40 to 200 USD per minute.[c,4]

While crises such as the Great Recession and the COVID-19 pandemic have short-term adverse effects, air traffic has a proven long-term resilience that leads forecasters to predict a world annual growth rate of at least 4.5% to the 2040 horizon.[d,5] Beyond 2040, the rise of Africa will continue to support this growth worldwide for several decades. Innovative air mobility will create a new demand as well. Enhancing the accommodation of this growing throughput with improving punctuality and resilience has been one of the main concerns of the air traffic management modernization effort that the world has undertaken under the umbrella of the International Civil Aviation Organisation's (ICAO) Global Air Navigation Plan (GANP). Leading local programs include NextGen in the United States and the Single European Sky (SES) in Europe. Other programs include Sirius in Brazil and CAAMS in the P.R. of China[6], and other countries are modernizing their ATM as well without a centralized management and branding.

Within an interconnected air traffic management process such as the U.S. National Airspace System (NAS) or the E.U. SES, issues faced by a single commercial airport and their impacts on the overall performance of the network have been highlighted. For instance, it was estimated in 2008 that 1 minute of original delay at a U.S. hub airport was resulting in 1.44 to 2.16 minutes of total delays considering the propagated arrival delay distributed across arrivals at one or more airports.[7] Airports are more interdependent and there is a need for an emerging concept of accountability for the delay one creates on the overall airport ecosystem. The Single European Sky (SES) approach includes a performance and charging scheme on air navigation services with an airport component.[8]

Collaboration Has Been a Game Changer

Collaboration between the stakeholders of real-time operations has been a game changer everywhere it has been implemented. The different organizations representing all the stakeholders of airport operations have called for the end of the "silo effect"[9] and have supported Airport Collaborative Decision-Making (A-CDM).[10,11] Airport CDM is now an international standard[12] and an objective of ICAO for advancing air navigation as part of the Global Air Navigation Plan (GANP).[13] The A-CDM concept that emerged in the years 1990 is about establishing a tighter relationship between the players of real-time airside operations and sharing information for the purpose of enhancing efficiency, reducing delays and improving resilience. The A-CDM "spirit" is based on trust and transparency to serve the common operational interest. One of the focus of A-CDM is to create a framework for the stakeholders to share operational data, have the same level of information, and decide collaboratively – not side-by-side only

[a] 2005 USD. 1 trillion = 1,000,000,000,000.
[b] Flights controlled by European Civil Aviation Conference (ECAC) members.
[c] Rough orders of magnitude in EUR_{2020}. Original figures in EUR_{2018} adjusted to inflation. 1 EUR_{2018} ≈ 1.02 EUR_{2020}. 1 EUR_{2020} ≈ 1.1 USD_{2020}.
[d] Compound Annual Growth Rate (CAGR) of the Revenue Passenger Kilometers (RPK) over the 2012-2042 (ICAO, 2016).

anymore – on how to address operational issues in a timely manner. The extension of this approach to the rest of the airport, from the access road to the airfield, is called Total Airport Management (TAM). A practical application of TAM is the Airport Operations Center (APOC) that integrate the different functions of real-time airport operations into a "single" physical or virtual facility with, as far as possible, the participation of all the internal stakeholders of the airport authority and the external stakeholders as well.

Establishing collaboration and deciding together means that everyone speaks the same language and agrees on set objectives and consensual remedies to adverse conditions. Stakeholders at pre-A-CDM airports have notoriously different definitions for the same milestones of the flight turnaround process. "Capacity" itself is even sometimes a taboo so much it can be interpreted in different ways depending on the user and its purpose. Airport CDM brings a common framework with joint key performance indicators and definitions on airport performance[14] and capacity.[15] Freed from their cultural differences, the airport operations community can focus on monitoring these KPIs, detecting coming adverse conditions when possible, and proactively managing them together.

After establishing a list of flights and their reference times (milestones) updated by each stakeholder for real-time operations and short-term planning purpose, it is possible to expand this vision months before for long-term operations planning purposes taking into consideration the evolution of the demand and any foreseen change in capacity (e.g., due to construction projects). Most of the commercial service airports already have an operations planning process. But an A-CDM vision of operations planning as promoted by ICAO in the GANP under the name of Airport Operations Plan (AOP) is the ultimate step of A-CDM implementation for integrated planning and management of operations. In Europe, the AOP concept of EUROCONTROL looks 180 days ahead and inform a network-wide operations plan (NOP).[16]

The benefits of collaboration are tremendous. A 2016 assessment by EUROCONTROL shows that across 17 CDM airports in Europe, ATFM delay has been reduced by 10.3%, the average taxi-time by 7%, and the fuel consumption, CO_2 and SO_2 emissions by 7.7%.[17] Europe and the United States have pioneered Collaborative Decision-Making. In Europe, CDM started from airports, and this recipe has been applied all around the world. These local A-CDMs feed a network-wide CDM model. In the United States, CDM started from the FAA Air Traffic Control System Command Center (ATCSCC) and the air carriers under the FAA/Industry CDM Stakeholders Group (CSG). There is a network CDM, but not yet local airport focused CDM as it can be experienced elsewhere. Airports shall be included as well, and several initiatives aim at giving a push to this movement, especially on the collaborative management of adverse conditions.[18]

From Reactive to Predictive M***anagement***

The step forward will be predictive management. Advanced collaboration has made available a large quantity of flight operations data collected into Airport Operations Databases (AODB) and other repositories. Processing these data through intelligent systems and organizations to predict potential disruptions, triggering preventive actions before it happens, and eventually mitigating their effect is now becoming possible. Moreover, this predictive management approach might be the next step in the advancement of airport and air navigation management while major modernization programs such as SESAR and NextGen are coming to an end, and the ICAO GANP itself does not provide a framework for the period beyond 2030 yet.

Information systems are enabling the current modernization effort in the airport and air traffic management. Intelligence systems will power the continuation of this effort toward a more capacitive, integrated and resilient aviation system, from the landside to the airspace. In the air, air traffic control is at the threshold of more automation. Most of the achievable optimizations under current concepts of operations have been implemented. For instance, the Wake Turbulence Recategorization (RECAT) has introduced new categories of aircraft for safely decreasing wake turbulence separations between some pairs of aircraft categories. The next step could be to characterize further aircraft pairs, with more categories or even by aircraft types. Ultimately, these separation minima could take into consideration local parameters such as the wind, and flight information such as the weight of the aircraft. Such progress could increase capacity but is not achievable without a higher degree of automation in air traffic control, providing the controller with a visual aid on the minimum separation between a given pair of aircraft or the automation of this instruction. Similarly, building on the experience of the pre-departure sequencers (PDS) of the A-CDM solutions, based on up-to-date flight key schedules and infrastructure capacities, air traffic controllers managing ground movements at large airports could be supported by machine learning from the local specificities including the choices made by the controllers and artificial intelligence to optimize dynamically taxiing. Georeferenced mapping information for enhancing navigation on the ground could be transmitted by datalink to the cockpit as well. This information could consider all active ground movement restrictions – e.g., aircraft type limitations, work in progress, etc. – for improving safety, mitigating incidents, and taxi efficiency.

On the landside, intelligence systems can assist the operations community in optimizing resources and proactively identifying coming demand-capacity issues. Many airports are already equipped with sensors or systems for measuring passenger flows and queues. Simple algorithms can be used to deduct the resource needed to process this throughput. Machine learning could recognize patterns in these flows, understand how the resource dynamically responds, and provide advice and scenarios to operations manager on the best way to proceed. Augmented reality and other advanced interfaces will enhance the visualization of these scenarios and data to facilitate their understanding and utilization. With the implementation of self-service devices and automated control systems, part of this decision-making process on resource management might start being automated or semi-automated by 2040. Significant progress can be made outside of the terminal building as well. Ground resources are often congested or utilized in a suboptimal way. Various stakeholders are present on the landside with few or no coordination. A CDM-like coordination between airport operators, ground mobility providers, and transit agencies is emerging and will bring a tremendous improvement. Adding potential transfers or rebooking between the air and rail modes would be an innovation and was explored as part of the EU-funded research project META-CDM.[19] The introduction of automated and connected vehicles (AV/CV), as well as Urban Air Mobility (UAM) could open new horizons on the coordination of the ground transportation offer to fit the demand, increase predictability and reliability, and reduce congestion and waiting times.

Such systems will need adequate infrastructure to exchange data. The System Wide Information Management (SWIM) is a global air traffic management initiative that is offering a data-centric framework for sharing these data. SWIM is one of the ICAO GANP items to achieve the global interoperability of systems and data. While SWIM has been designed for minimizing the interfaces and standardizing data sharing between the stakeholders of air navigation and flight operations management, it is a very powerful system. It has the potential of bringing together more aviation stakeholders or at least inspire a broader pan-aviation framework that could exchange information with non-airside parties, interconnect non-ATFM systems, and even enable data exchange with passengers.

Digital twins is another airport application of big data and intelligence systems to foster efficiency and resilience. A digital twin of a system is a digital replica and a detailed model of physical assets and processes that can be used for predicting and anticipating future issues or simulate scenarios. Airport digital twins can help with planning maintenance actions for asset management and financial planning purpose. They can also be used for running detailed and realistic “what-if” scenarios of future operations and provide extensive help to stakeholders to plan for future activity, optimize resources, increase revenues from retail, or facilitate the commissioning of new facilities.

Performance & Resilience Will Still Depend on the Human in the Loop at the Era of Intelligence Systems

Resilience starts on the first day of operations of a new facility with the Operational Readiness and Airport Transfer (ORAT) process. The commissioning of a new facility can be challenging, especially when a massive capacity is being delivered at the same time such as the new Beijing Daxing International Airport (PKX) and Istanbul Airport (IST). Architects, designers, and engineers shall keep in mind that innovation shall ultimately serve the operations. The first intelligence systems in aviation are the aviation professionals. Airports shall be easy to maintain and operate. Too many architectural features master the art of making the task of the operating staff impossible. Changing a light fixture shall never require custom-made equipment. Mechanical, electrical, and plumbing (MEP) systems shall be accessible to maintenance teams. An airport is a masterpiece only if it looks beautiful and operates efficiently at the same time. Decision-makers shall maintain awareness that if cost-saving policies and operational requirements are not balanced, efficiency and resilience will be at risk. A well-planned preventive maintenance program saves money. Airport helpers in terminal facilities make the journey smoother and reduce the stress of passengers. Redundancies are never regretted the day they prevent the airport from shutting down.

While information and intelligence systems can enable more performance, efficiency, and resilience, we have to be careful that these information and intelligence systems expected to make us more resilient do not actually turn our airports weaker. Indeed, these systems themselves can fail. Beyond redundancies and failsafe designs, simple contingency plans can be prepared to maintain the activity based on less “techy” processes even if it means to operate in degraded mode. For instance, Geneva Airport (GVA) trains agents to process passenger boarding with paper documents to continue operating in case the computers or readers available at the gate are out of order. These “what-if” based training strategies can “save the day” and way more while we are becoming increasingly dependent on technologies and systems.

Enhancing the long-term resilience to sudden shocks of demand, such as the COVID-19 crisis, is possible. Such a strategy requires an interdisciplinary approach that goes beyond the means and powers of the aviation industry and should be led or coordinated by governments and international organizations. COVID-19 per se could not have been foreseen. But the emergence of a new pandemic of respiratory disease after SARS and MERS and its effects on our society and the economy were. Unfortunately, despite these warnings, our nations were poorly prepared when the SARS-nCOV-2 virus spread in mainland China and then to the rest of the world at the beginning of 2020. What is the “next COVID-19”? New influenza or coronavirus pandemics will happen, and we can hope that the lessons learned from the COVID-19 will be used for making our society more resilient. New terrorisms, the collapse of the IT infrastructure, collateral casualties of conventional wars, and the impact of extreme weather due to human-induced climate change are other threats to aviation. On all these threats, transparency, collaboration, and planning are keys to prevent adverse events and provide an adequate and timely response when required.

Climate Change Will Challenge Aviation System Resilience

Climate change raises specific threats to resilience. Its effects on our infrastructure systems are already visible in 2020. Significant climate anomalies with a direct impact on our lives have now been recorded for over two decades.[20,21] They range from frequent record high temperatures to violent winter storms, and they have direct consequences on the health and availability of airport assets and both the operating and capital expenditures. Some of these events have been creating new paradigms regionally. The winter season 2010/2011 in Europe led to significant investments in winter equipment and support facilities, an effort to make operations more resilient. Similarly, Kansai International Airport (KIX) decided to heighten seawalls and one its runway by 1 meter following the damages from typhoon Jebi in 2018.

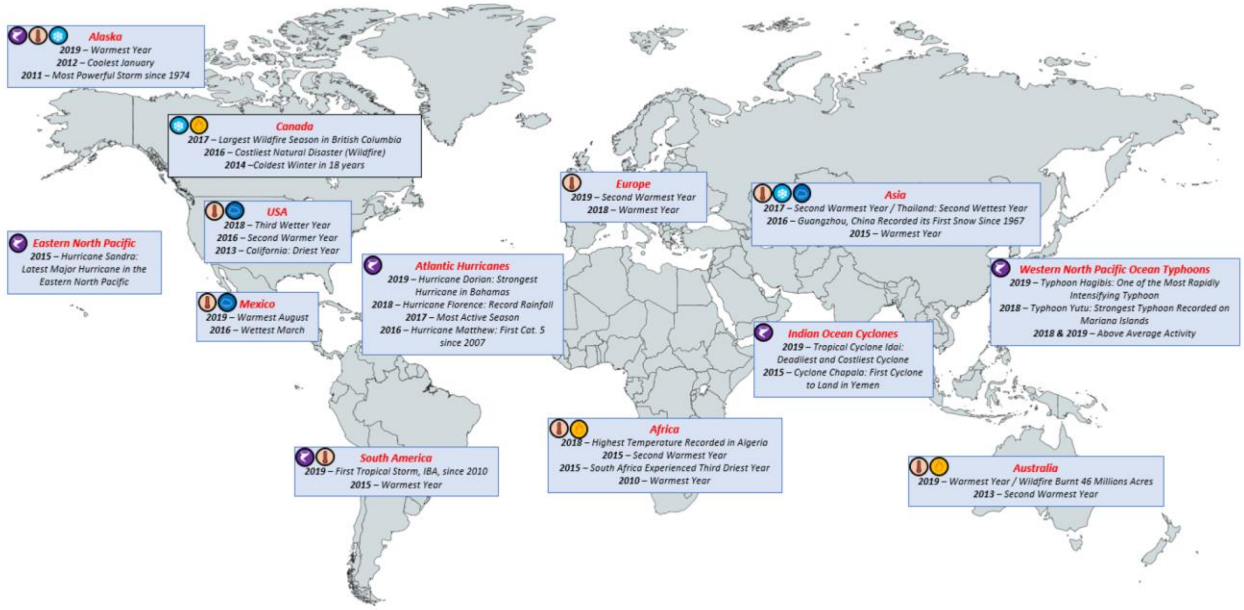

Figure 8-1 - Selected Climate Anomalies Between 2010 and 2013
Source: NOAA Annual Global Climate Report 2010-2019

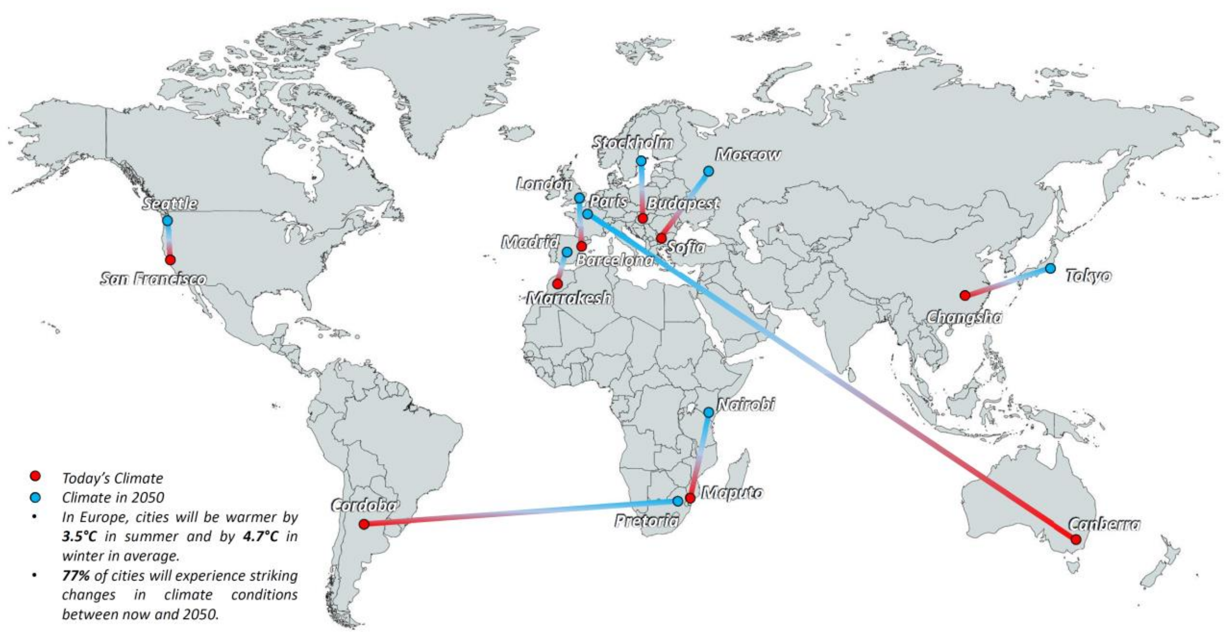

Figure 8-2 - Comparison Between City Analogues From a Climate Perspective
Source: Understanding climate change from a global analysis of city analogues, ETH Zurich, PLOS ONE, 2019

Beyond the extreme weather conditions, the overall climate is evolving. According to a study by a team of ETH Zürich researchers, the 2050 climate in London will be more similar to the current one in Barcelona. Seattle might experience conditions closer to today's San Francisco. Nairobi might feel like Maputo, and Tokyo like Changsha.[22] Such changes will redefine critical criteria for airport design and operations such as the 100-year floodplain, the average temperature, or the windrose. A significant change in climate might also have an impact on soils. The most expose airports to geotechnical changes are perhaps the facilities in the polar regions that lie on permafrost, a material whose specificities are changing under the warming of the local climate.[23]

The climate is warming globally, but it is also becoming more unstable, creating more anomalies that affect air traffic and damage infrastructure. For instance, NASA predicts an average of 2 to 3 days of additional days of thunderstorm conditions annually beyond the 2070 horizon compared to the second half of the 20th century.[24] Research works suggest that extreme El Niño–Southern Oscillation (ENSO) events could be more frequent.[25] ENSO is associated with wildfires in Australia and Southeast Asia (haze and low visibility) and heavy rains in Peru and Ecuador (flooding and erosion). In 2004, the southern States of Brazil experienced the landfall of Hurricane Catarina – a first by the weather records available.[26]

Global warming is not the end of aircraft de-icing activities – more the opposite as violent cold weather might happen even at locations that are usually spared by frost. While the frost-free season will be longer at several airports of the temperate zone[27], winter storms could be more frequent. In other words, to cover the same level of risk on operations as of today, airports and their stakeholders might have to conduct investments with lower benefit-cost ratios. Climate change will have a broader impact on operating costs. An increase in the number of hot days will trigger a higher utilization of air conditioning in the passenger terminal buildings – another case for more energy-efficient buildings – and can impact the commercial payload of some flights[e]. They will require construction projects to consider higher contingencies for covering interruptions and delays due to adverse weather conditions, including heavy rain and heat waves.

One of the most impactful and dramatic effects of climate change is the rise in the average sea level. Coastal airports – and metropolitan areas – are directly threatened by the rise in the sea level. Models show that some metropolitan areas might be permanently underwater.[28,29] Most of the Asian delta areas are terribly exposed. By 2070, most of Bangkok, Ho Chi Minh City, Shanghai or Tianjin could be permanently flooded if massive adaptation plans are not undertaken. Annual and decennial flooding events would flood commercial airports such as GIG, JFK, LGA, PHL, SDU, SFO, VCE, AMS, LCY under the same assumption. Some inland facilities are not necessarily spared by the redefinition of extreme flooding scenarios due to more violent rainfall events.

The U.S. Transportation Research Board (TRB) identifies 5 key issues regarding climate change resilience of transportation infrastructure: how best to use climate information to improve risk-based decision-making; how to communicate adaptation successes from individual local governments; how to build flexibility and adaptability into policies, designs, and standards; how to make a business case for adaptation; and how to facilitate managed retreat and discourage risky investments.[30] Major civil engineering work might have to be conducted to increase the climate resiliency of several airports. Kansai International Airport is the perfect example of the symptoms and remedies that other airports might have to face. New facilities will have to be designed to sustain the conditions of the long-term future. Ultimately, retreating will be the most adequate scenario for some facilities that are excessively exposed to extreme weather events – e.g., aerodromes subject to permanent flooding due to the rise of the sea level if costly actions are not undertaken.

[e] This statement applies to existing aircraft types only as new aircraft types have better takeoff performances.

Appendix 8-1 - Long-Term Threats to Airport Resilience

Threat	Recent Examples	Typical Effects on Airports	Global Mitigation	Airport-Specific Actions
Pandemics and epidemics	Ebola, SARS, MERS, COVID-19, Zika	Short-term & brutal drop in air traffic and revenues, workforce on sick leave, overflow aircraft to store on airfield, etc.	International coordination, trans-national transparent collaboration, national readiness, enhanced hygiene, disease-specific actions (e.g. mosquito control, stay-at-home, etc.), change in social behaviors, economic relief plans, etc.	Airport response plan, prevention plan, designs preventing airborne spread, regular cleaning of parts touched by passengers and workers, soap and hand sanitizer available, prevention voice messages in terminal buildings, specific measure toward arriving passengers, etc.
Climate change-induced extreme weather	Hurricane Barry, Hurricane Catarina, Typhoon Jebi	Interruption of air traffic, destruction of facilities, higher operating costs and capital expenditures, etc. *Note: climate change might create favorable conditions for a wider spread of mosquito-borne diseases.*	Climate resilience, strong reduction of overall carbon emissions and "negative emissions", etc.	Airport climate resilience plan, incorporation of future climate in planning & design, financial resilience to more regular extreme weather conditions, etc.
Terrorism	Salafi jihadism, white supremacism, radical anarchism, murder-suicide patterns	Medium-term drop in air traffic and revenues, etc.	Global War on Terrorism, intelligence and police efforts, state security strategies, mitigating the roots of terrorism, etc.	ICAO GASeP, local implementation of state security plan, secure-by-design facilities, airport community awareness programs, etc.
Cyberwarfare	State-sponsored cyberattacks	Power outages, systems are out of service, malicious diversion of systems, etc.	National cyber-counter terrorism, cooperation between intelligence community and industry, etc.	IT system hardening, redundancies, operational resilience with low-tech contingency plans, etc.
Conventional warfare	Libyan Civil War, War in Donbass	Drop in air traffic, destruction of facilities	Prevention of conflicts and promotion of enduring peace	Airport-to-airport mutual assistance, evacuation of civilian aircraft toward safe aviation facilities, etc.

Abbreviations

AAI	Airports Authority of India
AAJ	Airport Authority of Jamaica
ACAC	Airport Construction Advisory Council
A-CDM	Airport Collaborative Decision Making
ACRP	Airport Cooperative Research Program
ACSA	Airports Company South Africa
ADAC	Abu Dhabi Airport Company
ADM	Aéroports de Montréal
ADR	Aeroporti di Roma
AENA	Aeropuertos Españoles y Navegación Aérea
AFIS	Aerodrome Flight Information Service
AHA	Aviation Hazard Areas
AI	Artificial Intelligence
AMS	Amsterdam Airport Schiphol
ANAC	Agência Nacional de Aviação Civil (Brazil)
ANN	Artificial Neural Network
AOP	Airport Operations Plan
APOC	Airport Operations Center
APM	Airport People Mover
ARIWS	Autonomous Runway Incursion Warning System
ASEAN-SAM	ASEAN Single Aviation Market
ASUR	Grupo Aeroportuario del Sureste, S.A.B. de C.V.
ATAG	Air Transport Action Group
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
ATCo	Air Traffic Controller
ATFM	Air Traffic Flow Management
ATL	Hartsfield-Jackson Atlanta International Airport
ATM	Air Traffic Management
AV/CV	Automated Vehicles/Connected Vehicles
BCB	Body Cavity Bomb
BKG	Branson Airport
BNDES	Banco Nacional de Desenvolvimento Econômico e Social
BVLOS	Beyond the Visual Line of Sight
CAAC	Civil Aviation Administration of China
CAAMS	China's Strategy for Modernizing Air Traffic Management
CAG	Changi Airport Group
CAGR	Compound Annual Growth Rate
CAH	Capital Airport Holding
CDG	Paris-Charles de Gaulle Airport
CDM	Collaborative Decision Making
CNS	Communication, Navigation and Surveillance
DAC	Dubai Airports Company
DAESP	Departamento Aeroviário do Estado de São Paulo
DECEA	Departamento de Controle do Espaço Aéreo (FAB)
DFW	Dallas-Fort Worth International Airport

DGAC	Direction générale de l'aviation civile (France)
DOK	Donetsk Airport
EASA	European Aviation Safety Agency
ECAA	European Common Aviation Area
EGSA	Etablissement de Gestion de Services Aéroportuaires
EHCAAN	Egyptian Holding Company for Airports and Air Navigation
EMI	Electromagnetic Impulse
ENAC	Ecole Nationale de l'Aviation Civile
ENANA-EP	Empresa Nacional de Exploração de Aeroportos e Navegação Aérea E.P.
ENSO	El Niño–Southern Oscillation
ERAU	Embry-Riddle Aeronautical University
FAA	U.S. Federal Aviation Administration
FAB	Força Aérea Brasileira
FAB	Functional Airspace Block
FIT	Florida Institute of Technology
GACA	General Authority of Civil Aviation
GANP	Global Air Navigation Plan
GASeP	Global Aviation Security Plan
GASP	Global Aviation Safety Plan
GMF	Global Market Forecast
GMR Group	Grandhi Mallikarjuna Rao Group
GRU	GRU Airport / São Paulo/Guarulhos–Gov. André Franco Montoro Intl. Airport
GTAA	Greater Toronto Airport Authority
GTC	Ground Transportation Center
HCC	Hub Control Center
HKG	Hong Kong International Airport
IAD	Washington Dulles International Airport
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
Infraero	Empresa Brasileira de Infraestrutura Aeroportuária
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
IST	Istanbul Airport
JFK	John F. Kennedy International Airport
KIX	Kansai International Airport
KUL	Kuala Lumpur International Airport
LAC	Latin American and Caribbean
LAMP	Landside Access Modernization Program
LAWA	Los Angeles Airport World
LAX	Los Angeles International Airport
LCY	London City Airport
LGA	New York LaGuardia Airport
LGP	LaGuardia Gateway Partners
LGW	London Gatwick Airport
LHR	London-Heathrow
MaaS	Mobility as a Service
MANPAD	Man-Portable Air-Defense System
MDAD	Miami-Dade Aviation Department

MEP	Mechanical, Electrical, and Plumbing
META-CDM	Multimodal, Efficient Transportation in Airports and CDM
MIA	Miami International Airport
ML	Machine Learning
MRS	Marseille-Provence International Airport
MUC	Munich International Airport
MWAA	Metropolitan Washington Airports Authority
NEXTT	New Experience Travel Technologies
NFC	Near-Field Communication
NM	Network Manager
NOAA	U.S. National Oceanic and Atmospheric Administration
NOP	Network Operations Plan
O&C	Ownership & Control
OCC	Operations Control Center
OER	Örnsköldsvik Airport
ONDA	Office National Des Aéroports
ORD	Chicago-O'Hare International Airport
ORY	Paris-Orly International Airport
PHL	Philadelphia International Airport
PPP	Public-Private Partnership
PPP	Purchasing Power Parity
PKX	Beijing Daxing International Airport
PRT	Personal Rapid Transit
RAM	Rural (or Regional) Air Mobility
RESA	Runway End Safety Area
RIPS	Runway Incursion Prevention System
RIPSA	Runway Incursion Prevention through Situational Awareness
RIRP	Runway Incursion Reduction Program
ROAAS	Runway Overrun Awareness and Alerting System
ROPS	Runway Overrun Prevention System
RPA	Regional Plan Association
RPK	Revenue Passenger Kilometer
RPZ	Runway Protection Zone
RTC	Remote Tower Center
rTWR	Remote Tower
RVA	Régie des Voies Aériennes de la République Démocratique du Congo
SAAS	San Antonio Airport System
SAATM	Single African Air Transport Market
SAC	Secretaria de Aviação Civil (Brazil)
SAF	Sustainable Aviation Fuels
SAT	San Antonio International Airport
SARP	Standards and Recommended Practices
SDI	Space Data Integrator
SDL	Sundsvall–Timrå Airport
SES	Single European Sky
SFB	Orlando Sanford International Airport
SFO	San Francisco International Airport
SIIED	Surgically Implanted Improvised Explosive Device

SIN	Singapore-Changi International Airport
SJU	San Juan Luis Muñoz Marín International Airport
SMS	Safety Management System
SWIM	System Wide Information Management
TAM	Total Airport Management
TIP	Tripoli International Airport
TNC	Transportation Network Companies
TOSC	Technical, Operations & Safety Committee
TRB	Transportation Research Board
TRT	Turnaround Time
UAM	Urban Air Mobility
UATM	Urban Air Traffic Management
USOAP	Universal Safety Oversight Audit Programme
UTM	Unmanned Traffic Management
VCE	Venice Marco Polo Airport

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