ADAPTING AIRPORTS TO A NEW CLIMATE

BY OLAV MOSVOLD LARSEN (AVINOR)
AND KRISTIN FJELLHEIM (AVINOR)

In five consecutive reports since 1990, the International Panel of Climate Change (IPCC) has documented that global climate is changing. The latest report states: "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased"[1]. There is virtually no doubt that even if we could eliminate all of humanity's carbon emissions this afternoon the delay in the atmospheric response would – according to scientific projections – make the future climate significantly different from that of today.

Both in the near-term (2030-2040), and the longer-term (2040 onwards), the global mean temperature is projected to rise, but how much depends on the extent to which carbon emissions are mitigated. In general, there will be more extreme weather; dry regions will be drier and wet regions will be wetter. The temperature increases will be more pronounced closer to the poles, but there will be more days with heat extremes all over the globe. Many regions will see more precipitation, and also more very intense rainfalls and flooding, while other regions will see a decrease in rainfall, causing drought and water restrictions. Sea level rise, extreme precipitation, cyclones, and storm surges will affect coastal airports more often than today. These changes will happen gradually, but we have already seen extreme weather events that provide a glimpse of what will be "the new normal". Adapting to the future climate will be location- and context-specific, with no single approach for reducing risks appropriate across all settings[2].

Many airports throughout the world have extensive programs to reduce their emissions of Green House Gases (GHG) and programs such as Airport Carbon Accreditation[3] are gaining ground. But what about the other half of the equation? How will climate change affect airports and what can be done to make airport infrastructure more resilient to the future climate and to ensure safe and reliable operations?

Norway

Most of Avinor's 46 airports are scattered along the rugged Norwegian coastline. Twenty of them are quite exposed and several have runways less than 4 meters above sea level. No two airports are the same, and while risks can be identified at a high level according to climate zone and geographical location, the specific impacts each one will have to deal with may vary greatly according to operational and infrastructure characteristics.

Forecasting always implies a degree of uncertainty. Climate change at Norway's latitudes comes with huge seasonal, local and regional varieties but the future will generally be "warmer, wilder, and wetter". In the case of Avinor, "warmer" means, that the winter season will be shorter at all the airports and some airports will have to deal with troublesome +/- zero degrees-weather more often; less often at other airports. In this temperature range, snow melts and rain freezes, with possible reduced friction and slippery operational conditions as an outcome. Increased precipitation and freak rains challenge the drainage of runways, aprons, buildings and other infrastructure alike. In winter "wetter" could imply more heavy snowfalls with a risk of reduced punctuality and regularity. "Wilder" means more extreme weather events, storms and storm surges impacting traffic, causing delays, and potentially damaging infrastructure.

Cooperation

Avinor has been looking into climate adaptation strategies since the turn of the century. Within the government's National Transport Plan (NTP), an initiative of the Norwegian Ministry of Transport and Communications carried out every four years, Avinor along with the three transport directorates (road, rail and coast) have been asked to plan the national transport infrastructure. This created an awareness since quite early on of the overall risks, and what to expect in the future. It also showed that, compared with other modes of transport, aviation has the resources and capabilities needed to meet the challenges. Because airspace and runways are constantly monitored, airports can be closed if weather requires, thus limiting the level of risk to life and health. Furthermore, there is only a small risk of landslides and avalanches at airports. The same cannot be said for rail and road.

So, the point of departure for a robust "plan/do/check/act approach" was in place more than a decade ago. Ideally, the next stage should have been a thorough risk assessment of the overall situation at Avinor's airports and other critical infrastructure, identifying vulnerabilities and strengths, acknowledging the differences between airports, and analyzing how climate change would impact Norwegian airports differently in different regions.

Jump Start

However, we were forced to jump start things at the "do" part of the process when new legislation in 2005 required that safety areas at the sides and ends of runways at several airports had to be expanded. Climate change became a real issue for us when we realized the implications of the fact that the seabed close to

the runways in question was, in some places, very deep and that it would have a huge impact on the "storm proofing" of the safety areas. In collaboration with technical experts we had to look into the "wilder" aspects of climate adaptation. Projections of future sea levels, wind directions, wave directions and – in some instances – the underwater topography, were all taken into account to calculate the size, shape, and amount of rock fill needed to make robust safety embankments which would be able to withstand future storms.

Although Avinor has been aware of climate change and adaptation issues for some time, new legislation and real world projects forced it to take climate change into consideration during the planning and execution phases of a number of fairly large airport construction projects between 2006 and 2013. This evolved into Avinor creating its own set of internal guidelines for dimensioning criteria for safety areas at runways close to the sea, as well as strengthening requirements for potential new runways. As a result, they now have to be constructed at least 7 meters above sea level.

Another example of this is the water and drainage master plan carried out in the planning phase (2008-2009) of the terminal expansion and the related work on the apron at Oslo Airport (to be opened in March 2017). The study revealed that is was necessary, and thus it was decided, to add fifty per cent drainage capacity compared with the 1990s, when the airport was constructed.

Risk Assessment

In 2014, Avinor finally started the process of undertaking a systematic risk assessment of all of its airports, including connected navigation systems and surface access to the airports. A simplified version of the Heathrow methodology[4] was used as a starting point.

Many airport challenges have been fairly easy to define and identify, and they include drainage issues, wind issues, and flooding issues. But the risk assessment has also revealed air navigation service challenges (Avinor is also the national provider of air navigation services). For example, the electricity supply to navigation equipment at some of low-lying airports, is placed on the floor in their shelters. This is not a good idea when the airport is at risk of flooding, so this will be rectified. Other navigation infrastructure could also be vulnerable at times of storms and blizzards.

As far as the "warmer" challenge is concerned (which is relevant even in Norway), the risk assessment made Avinor question whether the cooling capacity in the server rooms at some of the northernmost airports is sufficient to withstand future forecast summer high temperatures. When it comes to air traffic management, a positive finding is that the transition to satellite based navigation will reduce the vulnerabilities mentioned above. Norwegian airports are used to handling fairly extreme winter conditions, but "wilder" winter weather could impact punctuality and regularity.

A 50 per cent drainage capacity was added as part of the terminal expansion of Olso Airport, compared with the initial airport drainage capacity decided in the 1990s.

A main variable is, however, hard to predict: the position of the North Atlantic jet stream which could impact local wind directions and thus cause cross winds at the runways more often than today. As a result of this uncertainty, it was recently decided in the master plan process at Stavanger Airport to keep the secondary cross runway as there has been a clear tendency towards changing wind directions over the last few years. The alternative was to have two parallel runways.

20-20 Hindsight

With the benefit of 20-20 hindsight, it is now clear that Avinor should have carried out the risk assessment a lot earlier. Based on that experience, the clear advice to others in the aviation industry is to proceed as soon as possible with this process. Appoint someone in the organisation to be responsible for climate change adaptation and carry out a risk assessment! Most airports already have risk assessment methodologies in place or there could be national guidelines that can be used. Use the one you are familiar with and it will be easy to communicate in your organisation.

Fortunately, the literature on aviation and climate change adaptation is steadily growing. ICAO has dedicated one chapter in each of its two latest Environmental Reports (2010 and 2013) to the issue. In the US, FAA supported by Airport Cooperative Research Program (ACRP) has been working on these issues for several years as evidenced by its report: "Airport Climate Adaptation and Resilience"[5], and the newly released report 147 on "Climate Change Adaptation Planning: Risk Assessment for Airports" which also includes an electronic risk assessment tool[6]. In Europe, EU and national authorities are publishing a steady stream of reports and recommendations. Since 2008, Eurocontrol has taken lead role in the aviation industry and included future climate change in their "Challenge to growth" reports. Eurocontrol also provides a very useful website[7] with a list of suggested literature and other information most relevant to the aviation industry. Examples of aviation reports online include the comprehensive climate change risk assessments carried out by NATS (the UK Air Navigation Service Provider)[8] and Heathrow Airport[9].

Buildings

Avinor has about 1.2 million square meters of building infrastructure of all types (e.g. terminals, operations buildings, hangars, office buildings, parking houses, etc.) spread out over more than 50 locations in the country. Although most of the buildings still have many years left before the end of use, many have recently come under scrutiny in terms of climate adaptation.

Adding to the cooperation activities mentioned above, Avinor recently joined a center for research based innovation relating

to climate adaptation solutions involving the other transport directorates, Norwegian financial institutions, industry, and academia[10]. This gives it a sneak peak into future climate adaptation measures and solutions. It also provide it with the opportunity to influence the research areas. As an example, Avinor's involvement has resulted in more research on solutions for existing buildings.

Avinor is also a property developer that builds new buildings and expands existing ones. In this process there are several elements to consider and it is easy to forget climate adaptation as it is not yet a well-established subject in the building industry. Avinor has tried to solve this by including climate adaptation issues in the requirements specification for these types of projects. These require that the building and the choice of materials must be evaluated in accordance with the local climate and the future predicted amount of precipitation, wind, and extreme weather, as well as having a sustainability focus. The concept of "building for a changing climate" but also changing user behavior is becoming more prominent. For example, the new requirement specifications state that the location and orientation of the buildings must be considered with regards to future precipitation and wind directions.

The ideal situation is that climate changes and climate impact factors be included in the lifecycle cost analysis so that any new buildings, and maintenance of existing buildings, will be both adapted to a changing climate, and climate impact will be minimized. Through a new strategy for maintenance of buildings and infrastructure, the lifecycle perspective will become more prominent in Avinor. By including climate change in the lifecycle cost calculations, many of the climate adaptation measures that might seem costly at the outset, will in fact reduce the lifecycle costs of the project.

Conclusion

Climate change is here to stay, and there will be significant regional and seasonal variations. There is thus no single approach to be taken. This article has provided some examples from the perspective of a Northern European airport operator's climate challenges and adaptation activities. Avinor's experience is that minor adaptation investments in already planned and/or ongoing projects can save on future resources.

Aviation is an extremely risk averse business. Climate change poses a new set of risks that airports need to assess properly. The last decades have provided a glimpse of the future climate, but the main effects will be more evident three or four decades from now, and onwards. There is thus no reason to panic, but much of the airport infrastructure erected today will be there in the new climate. A rational response at all airports is therefore to carry out risk assessments of existing and new infrastructure in order to think ahead, reduce risks, minimize life cycle costs, and ensure the reliability and regularity of the aviation sector.

Furthermore, aviation is dependent on all elements of the network to be fully functioning. All actors in the aviation industry should carry out risk assessments – which is not difficult – and decide if action is required.

It makes little sense to have islands of resilience in an ocean of vulnerabilities.

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