Knowledge for Climate

Future perspectives for a Regional Adaptation Strategy for

Hotspot Mainport Schiphol

Management summary

The purpose of the Knowledge for Climate (KfC) research programme is to carry out fundamental and applied research that explores how to climate-proof the Netherlands. Based on the outcomes of this research, the programme has developed future perspectives for Regional Adaptation Strategies (RAS) for eight 'hotspots' in the Netherlands. Schiphol Airport (Mainport Schiphol) is one of those hotspots. The RAS of Mainport Schiphol is based on literature reviews and discussions with experts.

The effects of climate change – different weather patterns and sea level rise – will become more apparent in the next few decades. The cimate scenarios developed by the Royal Netherlands Meteorological Institute (KNMI) – known as the KNMI'14 – and the IPCC's 2013 climate change report indicate temperatures in the Netherlands will continue to rise, resulting in more mild winters and hot summers. There will be more, and more intense, extreme rainfall, and more severe hail and thunderstorms. There will be minimal changes in wind speed and the number of foggy days will decline. The sea level will continue to rise; according to estimates, it will have risen by as much as 100 cm by the year 2100.

Current and local weather conditions are critical to operations at Schiphol Airport. The report 'Hotspot Mainport Schiphol – Future perspectives for a Regional Adaptation Strategy' (in Dutch) offers an initial outline for a climate change adaptation strategy for the airport. It is based on research into the climate change effects that will influence operations there. The report looks specifically at delays in departure, arrival and ground operations as well as damage to infrastructure and equipment and the associated expense. The report also considers the airport's drainage system, water buffers and flood risk management.

Even in the current situation, the Schiphol organisation is making an ongoing effort to manage the influence of the weather and limit any negative impact. Developing an adaptation strategy is a logical next step in this process. In practical terms, this report is meant to supplement and strengthen the process of 'adaptive management'.

This is a management summary of the report: G. Baarse (2014) Hotspot Mainport Schiphol – Visieontwikkeling Regionale Adaptatie Strategie (project HSMS3.1).

Key results

The most important general finding is that Schiphol's current operational and management practices offer a satisfactory context for managing the impact of climate change. There is no need for radical adjustments or interventions in the current situation or near future.

Flood risk is well managed at Schiphol. The airport is protected by primary and regional flood defences that both meet the Netherlands' most stringent flood safety criteria. The report recommends investigating the principle of multilevel safety to further improve flood safety. Schiphol could then function as a 'safe haven' or 'emergency airport' in the event of flooding elsewhere in the Netherlands.

The Royal Dutch Meteorological Institute's (KNMI) HARMONIE model is a good example of how a new technology can be developed and applied. The platform can make highly detailed weather forecasts on a 2.5x2.5-kilometre grid. The safety of airport operations can also be improved by monitoring systems such as WindVisions, which measures critical weather conditions (wind and visibility) during take-off and landing.

Building blocks

Based on this study, six topics have been identified that function as the 'building blocks' for developing an adaptation strategy. For each building block specific actions have been defined, as well as possible measures for future implementation. The actions relate mainly to 'adaptive management', monitoring and analysing changes in the weather, conducting research, and developing a number of physical and operational measures.

1. Wind and visibility

Prevailing wind and visibility are critical parameters that have the biggest impact on take-off and landing operations at Schiphol. Current climate models do not indicate trend-like changes in wind direction, wind speed or wind occurrence. Visibility depends on the occurrence of fog and/or low-hanging clouds. Current climate modelling tools cannot detect unambiguous trends suggesting changes in visibility. In other words, it is not possible to make long-range forecasts at the present time.

Adaptive management: Anticipate changes in future wind and visibility patterns.

Monitoring: Monitor whether there are any observable trends in wind and visibility owing to climate change. Look in particular at convective events (see 2. Convective events), an increase in surface water in the airport's surroundings (Haarlemmermeer polder) and changes in soil moisture content. The latter two can affect the formation of fog.

Analysis: Analyse the effects of climate change on wind and visibility and what this means for runway operational capacity in the shorter and longer term. Where necessary, adjust the runway system capacity in the longer term.

Research and development: Continue developing and applying predictive models such as the HARMONIE model and come up with methods to create 'future weather' scenarios.

Possible physical and operational measures:

1) Adjust operational planning for runway system use and 2) adjust the capacity of the runway system in the longer term.

2. Convective events

Convective events can impact runway utilisation and capacity. Convective events are weather events combining heavy rainfall, thunderstorms, gusts and hail; their frequency and intensity will increase as temperatures continue to rise. As a result, pilots and air traffic controllers will be dealing more often with poor visibility during take-off and landing. Weather variability – and thus unpredictability – is also expected to increase, leading to more frequent disruptions in scheduled (and increasingly automated) flight operations and routes.

Accumulated rainwater on runways affects aircraft braking capacity, while hail can lead to delays in open-air platform operations and to damage to aircrafts. Current climate change scenarios do not report on the incidence of

lightning and thunderstorms. However, we can expect lightning to strike more often in the summer, certainly during convective events.

Adaptive management: Anticipate the effects and frequency of convective events.

Monitoring: Monitor the frequency and intensity of extreme rainfall, lightning and gusts in relation to disruptions in runway and platform operations and damage due to hail or flooding.

Analysis: Analyse protocols for runway use in the event of extreme weather and adjust runway capacity accordingly. Take into account future automation of flight plans and the disruptive impact that convective events may have on them. Analyse measures to prevent rainwater from accumulating on runways.

Research and development: Improve detailed weather modelling tools in order to estimate the frequency and intensity of convective events.

Possible physical and operational measures: 1) Adapt the protocols for dealing with convective events, 2) make physical changes to runway surfacing and drainage systems, and 3) introduce measures intended to prevent and/or limit local flooding (or flood damage).

3. Wintery conditions

Wintery conditions will have a moderate effect on Schiphol operations. Current climate change scenarios provide no explicit information on how many days of frost can be expected, or on the occurrence of snow, hail and ice. On the one hand, it is reasonable to expect rising temperatures to result in less frequent occurrences of frost. On the other, the weather is becoming more variable, so it is not at all clear whether we will see less wintery precipitation in the future. Changes in the jet stream and cold air outbreaks could also increase weather variability.

Adaptive management: Explore the possible effects of wintery precipitation and quantify the capacity and cost of snow removal and de-icing operations.

Monitoring: Monitor the duration and frequency of critical wintery conditions and their consequences.

Analysis: Identify the effects of possible future changes in the duration and frequency of critical wintery conditions. Analyse the procedures and capacity of measures designed to manage such conditions.

Research and development: Use monitoring and analysis to determine whether snow, ice and slippery conditions can lead to runway utilisation

and capacity problems and to an increase in the number of de-icing operations.

Possible physical and operational measures: 1) Adjust procedures for snow removal and de-icing, and 2) adjust the capacity of the snow-removal fleet and de-icing systems.

4. High temperatures

Higher temperatures will have a limited effect on airport operations, but they will nevertheless have a number of consequences. Higher atmospheric temperatures influence air density and thus aircraft lift during ascent. That affects carrying capacity and air transport efficiency, leading in turn to higher fuel costs. Aircrafts waiting at the gate will heat up faster, resulting in higher cooling costs.

Adaptive management: Survey and quantify the effects of higher temperatures on airport operations and the associated costs.

Monitoring: Monitor the number of days that temperatures exceed a critical value and document the effects, such as duration, scale, cost of cooling units and number of times that weight restrictions are imposed on cargo aircrafts.

Analysis: Identify fluctuations in the frequency of maximum daily temperatures and analyse potential measures, such as the capacity of cooling facilities.

Research and development: Develop methods for quantifying the impact of higher temperatures.

Possible physical and operational measures: 1) Expand the capacity of aircraft cooling facilities at the gate, and 2) adjust cargo aircraft operations.

5. Drainage system and water buffers

Adequate drainage is critical to operations at Schiphol. Climate change will cause more fluctuations in the water table. A small amount of land subsidence (10 to 20 cm per century) can also be expected. Both effects can be compensated by regularly scheduled maintenance of runways, roads and other paved surfaces.

The existing pumping stations in the Haarlemmermeer polder can cope with more frequent extreme rainfall, but additional measures are needed to meet the area's future water buffering needs. This will require a sizeable investment in the longer term.

Adaptive management: The drainage situation will remain stable and under control in the decades ahead. Eventually, climate change may require substantial investments in extra water buffering capacity. The expertise and procedures are already available, so the recommendation is to put off taking action and monitor the situation.

Monitoring: Monitor the occurrence of extreme precipitation and adopt a set of design standards for the drainage system. Also monitor whether the capacity of the drainage system and water buffers needs to be increased.

Analysis: Analyse whether more drainage facilities and water buffers are needed. If more water surface area is added, check whether problems arise owing to collisions with birds (water fowl).

Research and development: Not directly applicable, because the expertise is already available.

Possible physical and operational measures:

1) Increase the capacity of drainage facilities and water buffers in the longer term, and 2) take specific steps to limit problems arising from collisions with birds (water fowl).

6. Flood risk management

Flood risk management is extremely important for Schiphol. The airport is protected by primary and regional flood defences that meet the Netherlands' most stringent flood safety criteria. The risk that both would fail is very small. Even if that should happen, flooding would not exceed 0.5 metres depth. A shallow flood of this kind would claim a negligible number of victims, but the damage to the airport's image and the economic impact on the entire international air transport sector would be immense.

Research is therefore recommended to improve flood risk management, preferably by applying the principle of multilevel safety. It would also be interesting to explore whether Schiphol can serve as a safe haven or emergency airport in the event of flooding elsewhere in the Netherlands. Schiphol would then act as an 'air bridge' to safer areas.

Adaptive management: More in-depth research is needed to estimate and assess the risks of climate change.

Monitoring: Monitor fluctuations in the 'representative high-water discharge levels' *[Maatgevende Hoogwaterstanden]* in the regional water system owing to climate change.

Analysis: Analyse cost-effective measures based on the principle of multilevel safety to limit the risk of flooding, and analyse whether Schiphol can serve as a safe haven or emergency airport.

Research and development: Determine the current and future flood risk at Schiphol. Track the consequences of developments at the national level for regional flood safety and the stability of regional flood defences in the event of a primary flood defence failure, and the consequences for the 'representative high-water discharge levels' in the regional system.

Possible physical and operational measures:

1) Continue reducing the risk (and consequences) of regional flooding based on the principle of multilevel safety, and 2) make changes in order to allow Schiphol Airport to function as a safe haven and/or emergency airport.

More information and research results on hotspot Mainport Schiphol:
http://knowledgeforclimate.climateresearchnetherlands.nl/hotspots/schiphol-mainport