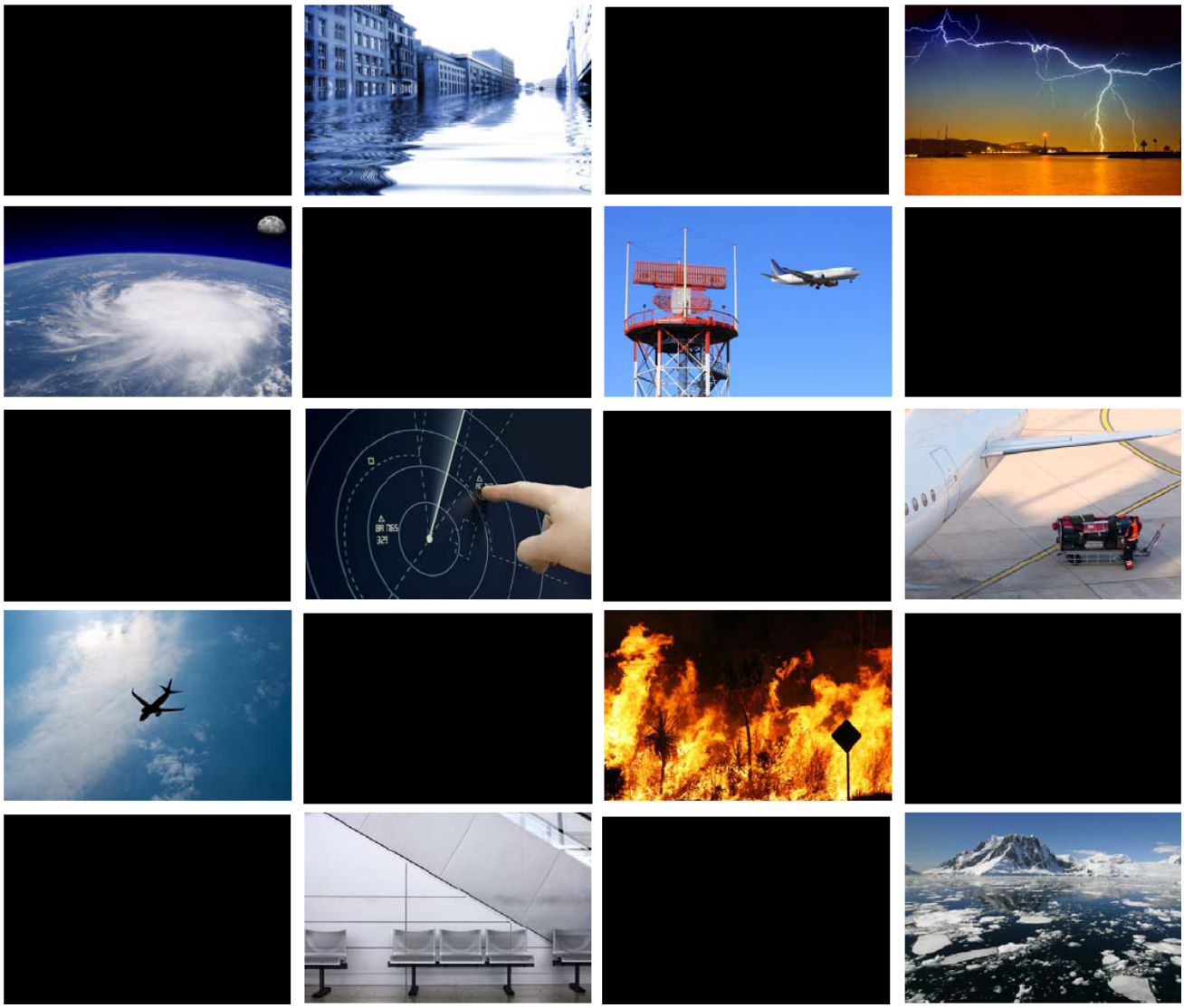
Climate Change Adaptation Report
July 2011



Executive Summary

NATS recognises that human-induced climate change is happening, and that as a responsible player in the aviation industry we have a part to play in reducing the impact aviation has on the environment.

We also recognise that there is a pressing need to adapt to climate change; both in terms of our estate and in the way we provide air traffic services (and other services). This does not mean we just have to consider the risks and take short term action, but by taking specific strategic actions and building these into our business plans, we will ensure that the services we offer to our airline customers remain resilient to the manifestations of climate change. This will guarantee that NATS will continue to provide a safe, expeditious and environmentally efficient air traffic service.

This report details how NATS is assessing the risks posed by a changing climate, and how we have adapted our business to ensure resilience to climate change effects.

NATS' role within the aviation industry and the role it plays as an Air Navigation Service Provider is described. How NATS prioritises and balances the competing demands of safety, capacity and environment, and how it manages risk using its risk management system are also examined.

NATS had extant systems in place which were able to adapt to climate change before the DTR was issued. This is described along with how adaptation to the risk from climate change has been embedded in the risk assessment processes including asset management, investment, supplier review, contingency, strategic project requirements, etc.

NATS have invested significant levels of resource in investigating the potential impacts of climate change. Our approach has been to utilise the expertise of in-house staff, supported and informed by expert professional advisors & academic authorities.

NATS is well positioned to adapt to those climate change effects which manifest themselves in meteorological phenomenon. Our operations are adapted daily to adjust to adverse weather effects, hence this capability is built into the organisation. The effects which have been identified as posing a more fundamental risk however, are those climate change effects which could undermine the financial health of the company.

NATS has a defined risk management system, and using this methodology the potential risks to NATS' business due to climate change are identified and the most significant risks are then examined in further detail. The primary risks identified include:

- Snow, sleet, blizzard and Ice,
- jet stream movement,
- change in the perception of air travel by the public,
- externally imposed restrictions to the number of flights.

The cost of implementing the adaptive action plan could increase NATS cost to the extent that it would be impossible to absorb them. Hence it would be necessary to pass the cost increases on by increasing prices. If restrictions in the number of flights was also imposed, the loss of revenue to NATS coupled with increased costs would present a double financial impact on the company.

The adaptation programme is expected to reduce the residual risk to NATS from climate change. The impact of climate change is one of many important variables that is considered in NATS strategic and business planning processes. However the adaptation programme has raised awareness of the issues and has ensured that climate change risks are considered as part of our normal business processes.

Contents

1. Climate Change Adaptation Reporting

The Government is committed to ensuring the public sector is taking action to adapt to climate change.

The Climate Change Act 2008 introduced a new power for the Secretary of State to direct "reporting authorities" to prepare reports. The Act gives the Secretary of State the power to direct reporting authorities[1] such as NATS to produce reports on:

- the current and future predicted impacts of climate change on their organisation; and
- the organisation's proposals for adapting to climate change.

This report is intended to satisfy this legal requirement, and demonstrate how NATS is assessing and acting on the risks and opportunities from a changing climate. This report is structured according to the guidelines given by Department for Environment, Food and Rural Affairs (DEFRA) for reporting authorities. These guidelines are published on the DEFRA website www.defra.gov.uk .

2. What NATS does

NATS has two business areas which are operated by two separate companies. NATS enroute Ltd (NERL) provides enroute ATC services, and NATS Services Ltd (NSL) provides ATC services at airports.

NATS enroute Ltd (NERL) provides air traffic control (ATC) services from its Area Control Centres at Prestwick and Swanwick to aircraft flying in UK airspace, and over the eastern part of the North Atlantic. In 2009/10 NATS handled nearly 2.2 million flights and carried more than 200 million passengers safely through some of the busiest and most complex airspace in the world. NATS is the sole provider of en-route air traffic services in the UK, where it is licensed and economically regulated by the Civil Aviation Authority (CAA). Originally a function within the UK's CAA, NATS (National Air Traffic Services) became a separate entity in 1996.

Through NATS Services Ltd, we also provide air traffic control services at fifteen of the nation's major airports including Heathrow, Gatwick, Stansted, Birmingham, Manchester, Edinburgh and Glasgow, together with air traffic services at Gibraltar Airport. Support services offered by NATS Services Ltd include communications, navigation and surveillance infrastructure, as well as commercial, engineering and consultancy services around the world.

Climate change will impact NATS directly across all parts of our business, as well as being indirectly impacted by the affects climate change will have on our customers and suppliers.

NATS enroute Ltd (NERL)

NERL is the sole provider of "enroute" Air Traffic Control services in the UK. It operates from two centres, at Swanwick in Hampshire and Prestwick in Ayrshire. The enroute air traffic control business is operated under a licence issued by the Secretary of State for Transport and economically and safety regulated by the Civil Aviation Authority (CAA).

NATS Swanwick
NATS Swanwick handles aircraft flying over England and Wales. It combines the London Area Control Centre, the London Terminal Control Centre, and military operations.

London Area Control Centre The LACC manages enroute traffic within controlled airspace in the London Flight Information Region, including airspace over the whole England and Wales up to the Scottish border.

London Terminal Control Centre handles traffic below 24,500 feet flying to or from London's airports. This area, which is one of the busiest in Europe, extends south and east towards the coast, west towards Bristol and north to near Birmingham. It also provides an approach service to aircraft inbound to Heathrow, Gatwick and Stansted ensuring aircraft descend in a safe and orderly stream ready to land. At busy times, aircraft are directed to holding stacks. Here they descend, under the controller's guidance, before being

[1] organisations with functions of a public nature and statutory undertakers

sequenced and released for their final approach. Aircraft flying from London's airports are handed over to terminal control shortly after take-off.

London Military Control provides air traffic control services to civil and military aircraft operating outside controlled airspace. The military controllers work closely with civilian controllers to ensure safe co-ordination of traffic. Military air traffic services include:

- radar control to aircraft flying in uncontrolled airspace above 24,500 feet
- radar control of aircraft crossing national airways.
- the Distress & Diversion cell, which is responsible for all military and civilian aircraft experiencing an emergency

NATS Prestwick

With the opening in 2009 of the new Prestwick Centre, NATS completed its ten-year strategy to reduce the number of air traffic control centres from four to two. The benefits of consolidation include cost, security and improved operational efficiency.

The Prestwick Centre combines:

Manchester Area Control Centre (MACC), which controls aircraft over much of the North of England, the Midlands and North Wales from 2500 feet up to 28,500 feet.

Scottish Area Control Centre (ScACC), which controls aircraft over Scotland, Northern Ireland, Northern England and over the North Sea from 2500 feet up to 66,000 feet.

Oceanic Area Control Centre (OACC) which controls the airspace over the eastern half of the North Atlantic from the Azores (45 degrees north) to a boundary with Iceland (61 degrees north), up to 66,000 feet.

RAF Prestwick, which comprises Scottish Air Traffic Control Centre (Military), controlling military aircraft operating above Scotland and northern England, and the Distress & Diversion cell, which is responsible for all military and civilian aircraft experiencing an emergency.

NATS Engineering

To ensure the highest levels of safety, controllers need highly reliable equipment. NATS engineers are responsible for maintaining integrated systems that support around 250 civilian and military ATC positions. Engineers operate comprehensive safety management procedures to safeguard these vital functions. System control ensures radar and radio coverage 24 hours a day, 365 days a year. NATS engineers also run the National Airspace System – a computer system that holds a database of all scheduled flights and provides flight progress strips to the air traffic controllers.

Swanwick and Prestwick receive radar information from 17 radar sites, as far apart as Sumbrugh in the Shetland Islands and Jersey in the Channel Islands. Engineers ensure 21 transmitter and receiver sites provide radio coverage via more than 140 channels.

NATS Services Ltd (NSL)

NATS Services encompasses the unregulated business of the NATS group. NSL works with airports, other air navigation service providers and customers from around the world to address their toughest ATC challenges.

NATS Services is a unique company formed from a unique situation. When the UK Government part-privatised NATS in 2001; NATS was granted a licence by the Secretary of State for Transport to provide services in enroute and oceanic airspace. This licence did not extend to tower and approach control services at airports however, which are now managed as contestable markets within the UK. Airports can decide how to manage their air traffic control and all associated procedures and disciplines.

Considering the safety, complexity, capacity and efficiency requirements this places upon an airport, many choose to outsource this. NATS Services is the leading provider of airport air traffic control services in the UK.

NATS Services has expanded its services to support customers globally, helping them to solve their most problematic issues in a world where costs and capacity must be satisfied without compromising safety.

NATS Services focus is on safety, service and increasing value for our customers.

Stakeholders

NATS key stakeholders are:

- The travelling public, who are the end customers of our services
- The general public living beneath flight paths
- Airlines, who use air traffic services directly
- Airports, who provide services (including Air Traffic Control) to the airlines
- The military, to whom NATS provide ATC infrastructure and other services
- Aircraft owners and operators and all airspace users (including General aviation, gliders, balloons, parachutists, etc)
- NATS shareholders who comprise
    - HM Government (49%)
    - The Airline Group - A consortium of airlines (42%)
    - The BAA (4%)
    - NATS Employees (5%)
- The UK Government (through the Civil Aviation Authority) who grant NATS its licence to operate enroute air traffic services and regulate NATS operations.

Environment

NATS accepts that human-induced climate change is happening, and that as a responsible player in the aviation industry we have a part to play in reducing the impact aviation has on the environment and climate change.

We also recognise that there is a pressing need to adapt to climate change; both in terms of our estate and in the way we provide air traffic services (and other services). This does not mean we just have to consider the risks and take short term action, but by taking specific strategic actions and building these into our business plans, we will ensure that the services we offer to our airline customers remain resilient to the manifestations of climate change. This will guarantee that NATS will continue to provide a safe, expeditious and environmentally efficient air traffic service.

NATS is the first Air Navigation Service Provider (ANSP) in the world to benchmark its environmental performance, and has set a target of reducing ATC-related CO_2 emissions by 10% per flight by 2020.

In July 2010, as a joint exercise between NATS and the "Sustainable Aviation" partners BAA and BA, an important environmental milestone was achieved by turning the regular Saturday evening London-Edinburgh service into the UK's first "perfect flight". To accomplish this every part of the journey was optimised to reduce CO_2 emissions, demonstrating how the optimisation of flight profiles can result in significant reduction in emissions of greenhouse gases.

NATS works closely with its partners worldwide. We support the work of the Civil Aviation Navigation Services Organisation (CANSO) in striving for more uniform environmental standards in air traffic management, and are closely involved with its work in creating targets for carbon emissions. NATS is also one of the founder members of "Sustainable Aviation", which sets out the collective approach of UK aviation to ensuring a long-term, sustainable future for the industry.

Safety

The safety of all flights is NATS' primary concern. NATS applies a systematic safety management system to all of its operational activities. We were one of the world's first air traffic management providers to implement a safety management system. This formal approach is founded on documented safety policies, safety principles and safety procedures. The system forms the basis for risk assessment, safety assurance, safety control and safety monitoring.

Through the Safety Management System (SMS), safety is given the highest priority by rigorous reviews of the safety implications of every activity within the ATM operation. The SMS maintains explicit safety standards which comply with national and international obligations.

Our service is delivered by highly trained air traffic controllers supported by sophisticated technical systems. Controllers undertake an extensive three year training programme from initial entry to becoming fully operational. They are then subject to a continuous process of assessment of operational competence with annual reviews and re-validation by the safety regulator.

NATS is subject to thorough safety regulation by the Civil Aviation Authority which is a global leader in the field of regulating air traffic services. The model of independent safety regulation is increasingly being adopted world-wide in the Air Traffic Management industry.

Independent safety advice is provided by the Safety Review Committee (SRC) a high level Board committee supported by independent experts from safety related fields that assists NATS in setting new 'best in class' safety standards. The role of the SRC is to monitor and review the effectiveness of the safety arrangements in place in the company and provide advice on improvement where necessary.

The Committee is authorised to seek any information it requires from any employee of the company in order to perform its duties.

NATS monitors safety performance using a comprehensive safety incident reporting and investigation process. This provides vital information that is used to identify areas for safety improvement. NATS is committed to maintaining a 'just' culture to encourage the free and honest reporting of safety incidents and concerns.

Capacity

The conditions of NATS' license to operate ATM services in UK airspace dictate that NATS must:
"**be capable of meeting on a continuing basis any reasonable level of overall demand for such services**".
(http://www.caa.co.uk/docs/5/ergdocs/20110101NERLLicence.pdf Page 15)

NATS has accommodated the historic growth in demand for air travel, by a constant process of improving airspace, improving controller tools and processes. This has ensured that the capacity of the air traffic management system has been sufficient to cope with demand. When demand exceeds available capacity, the safety of the system is maintained by delaying aircraft so that the volume of traffic does not exceed safe levels. As a result of systematic improvements in capacity the delays attributable to ATC have been kept at a low level (2009/2010, average 4.3 seconds NATS ATC attributable delay per flight).

Future traffic volumes are forecast using assumptions about future economic growth, airport capacity levels, airline behaviour (load factors, aircraft size) and other assumptions that are deemed to have a material influence on either the demand for, or supply of, air travel such as Open Skies. Three forecasts (High case/base case/low case) are produced. The base case forecast provides the most likely outcome and the high/low cases form the optimistic/pessimistic scenarios. These forecasts are used to inform NATS' decisions relating to financial planning, operational capacity planning, pricing, staffing, and service delivery performance.

Future capacity is modelled annually to identify areas where future demand is likely to exceed capacity. This allows any areas requiring redevelopment to be identified early, and enables the programme of infrastructure changes (which take several years to implement) to be prioritized effectively.

Contingency

NATS currently has several contingency systems in place to deal with a variety of disaster scenarios. Contingency procedures include the ability to cope with extreme events, and provide a limited ATC capability in the unlikely event of a disaster at one of the NERL centres.

A facility exists that is capable of taking over immediately in the event of a catastrophic event, which renders one of the control centres inoperative.

The NATS Air Traffic Incident Co-ordination and Communication Cell (ATICCC) provides a crisis management cell specifically designed to co-ordinate contingencies and communicate with customers in the event of an incident which impacts the UK ATM system. The last large-scale use of the ATICCC was during the volcanic ash incident in April 2010, when the ATICC served as the command & communications centre.

In the UK, the National Airspace Crisis Management Executive (NACME) provides a coordinating body for those organisations involved in the recovery from major incidents and unforeseen occurrences that impact on UK airspace. Its members include NATS, the CAA, Department for Transport and Ministry of Defence.

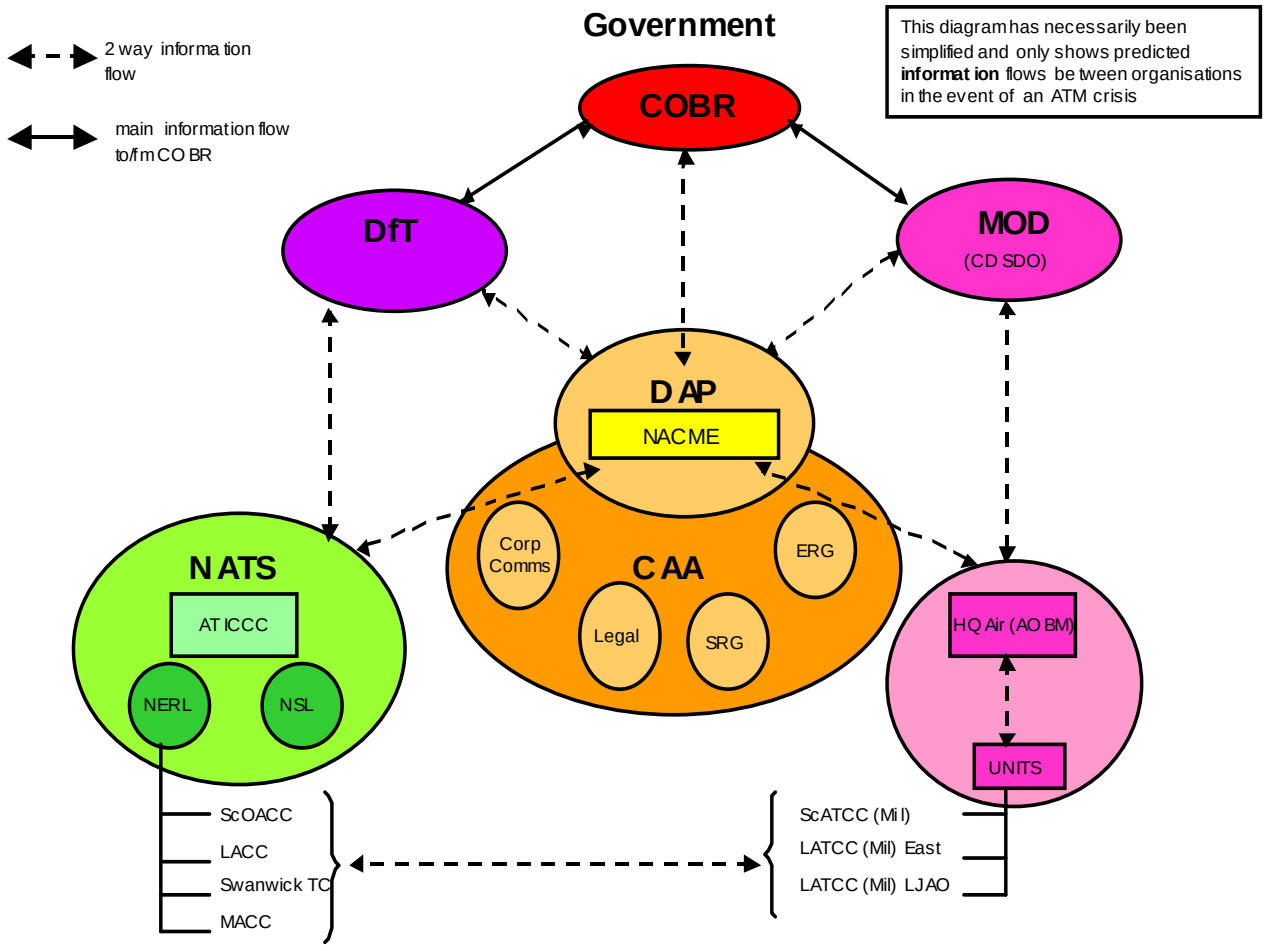


Figure 1 Information Flow Diagram

Risk Management

NATS has an established risk management system which is robust in its management of threats to the air traffic management system. Procedures exist and contingencies are in place to assure safety, and minimise disruption in the face of every conceivable perturbance to the normal operation of the system. The challenges presented by changes in the climate will be managed within this system.

Long term risks such as those resulting from climate change, will be identified and monitored within the risk management system. The possible risks are listed in section 4.

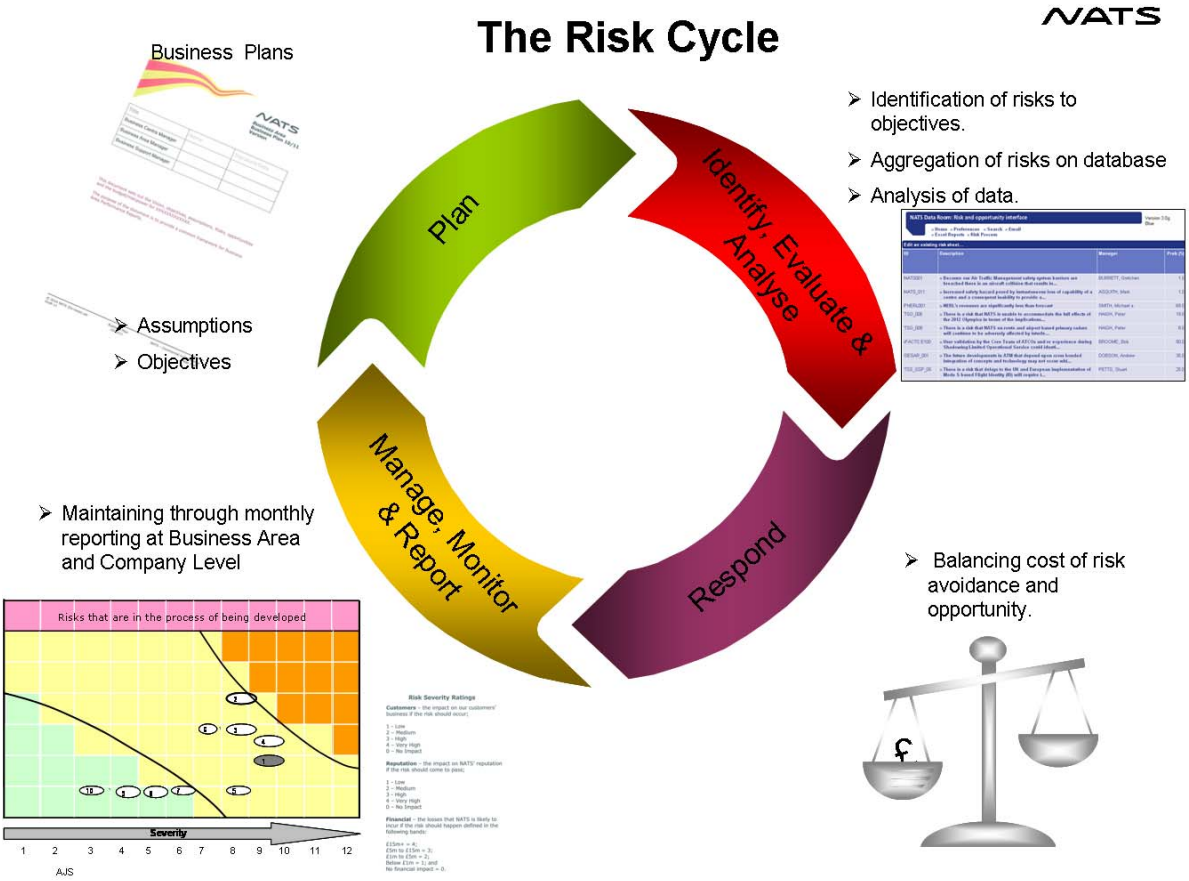


Figure 2 Risk Management System

3. Business preparedness before Direction to report was issued

NATS accepts that global warming is happening and that as part of the aviation industry we have a part to play in reducing the impact aviation has on the environment, global warming and climate change. In 2008 NATS set itself the publicly declared target that 'by March 2020, we will have co-operated with the industry in reducing ATM CO_2 emissions by an average of 10% per flight (against a 2006 baseline)'.

In January 2009, as part of its climate change strategy, the Government set a UK aviation target, to reduce UK aviation emissions back to 2005 levels by 2050. NATS recognises the pressing need to adapt to climate change; both in the way we provide an air traffic services as well as in long term planning.

In January 2009, prior to receiving the direction to report, NATS produced an internal Policy paper, the purpose of which was to better understand how the effects of climate change and climate change events would impact our operations, systems, people and business.

In studying the existing research, most estimates provided in reports and studies (e.g. predictions of average air temperature) examine changes spanning periods up to 2080 and 2100. The Stern Review looked at some forecasts up to 2035. However NATS also needs to understand the possible effects of climate change over shorter term timescales. Without this it is difficult for NATS to develop a strategy that can mitigate near-term climate change risk.

The need for shorter term predictions led to NATS' Research and Development department to commission a report by external consultants to assist in the understanding of the likely impact of climate change on our core business up to 2025. The objectives of the report were to:

- Summarise the anticipated climate change to 2025;
- Quantify the impact on the demand for air travel;
- Identify the impact on NATS' business and infrastructure.

The work was undertaken by a team of nine consultants including the Met Office, Professor Callum Thomas at Manchester Metropolitan University, and Environmental Resources Management Ltd. (Ref. 1)

Pre existing strategies for adapting to Climate Change

Before the Direction to Report, NATS' strategy for adapting to climate change was to use the existing risk management system (Figure 2) as follows:

1. to identify the risks
2. register these risks within the NATS risk management and asset management systems
3. establish contingency procedures to be instigated in the event that a risk manifests
4. monitor progress of the risk regularly

Climate Change Risk Assessment Embedded into the Organisation

Asset Management

The NATS asset management system[2] incorporates Asset Health Reviews, which schedule regular reviews of all systems and buildings. These reviews will incorporate consideration of the effects of climate change. The Asset Design Authority will identify whether any of the predicted effects of climate change will impact the ability of an asset group to provide an acceptable level of service up to the planned retirement date of the asset. This highlights any issues to the Asset Manager for them to deal with in an appropriate way.

[2] NERL asset management procedures conform to the British Standards Institute PAS55 - Optimal management of physical assets

Investment Process
The NATS investment process has been changed to ensure that new projects have explicit requirements to factor the effect of climate change into the design of new systems or buildings.

Strategic Project Requirements
Project requirements shall ensure that the delivered solution is tolerant (it can still provide an acceptable service level) of the predicted climate changes to a date equal to the Asset life plus three years.

Supplier review process
When scoring suppliers and in the standard contract terms, the ability of the supplier to adapt to climate change will be a consideration. The supplier shall assure NATS that the solution delivered by the contract is tolerant (it can still provide an acceptable service level) of the predicted climate changes up to the end of the Asset life plus three years.

Contingency review process
The Contingency Solution Design Authority will identify whether any of the predicted effects of climate change will impact the ability of the NATS contingency solution to provide, if required, an acceptable level of service.

Design Standards
All of NATS infrastructure and systems are designed to conform with national and international industry standards. As these standards apply within Europe and across the world in countries where existing conditions are similar to those projected to occur in the UK by 2080, it demonstrates a degree of extant resilience to the expected climate change.

The above processes and standards provide a number of systems embedded within the organisation. These systems provide a framework within which the risks of climate change will be monitored, and adaptation managed.

4. Identifying risks due to the impacts of climate change

NATS have invested significant levels of resource in investigating the potential impacts of climate change. Studies have been commissioned involving the Environmental Resources Management Limited (ERM), in partnership with the Met Office and the Centre for Aviation Transport and the Environment (CATE) at Manchester Metropolitan University. The work contributing to climate change adaptation has been coordinated by NATS Policy department, and has called upon expertise throughout the company. Expertise has been employed from the following areas within NATS:

- Operational Analysis
- Research & Development
- Asset Management
- Human Resources
- Engineering
- Policy
- Investment Group
- Environmental & Community Affairs
- Operational Performance Information (Forecasting)
- Business Performance
- Operational Units

Our approach has been to utilise the expertise of in-house staff, supported and informed by expert professional advisors & academic authorities. This has resulted in quantitative analyses, (e.g. by Operational Analysis) and qualitative analysis (e.g. by Operational Performance Information).

5. Assessing risks

Methodology

NATS has a robust risk management process[3] that has been developed over time to a maturity level that meets the requirements of ISO 31000. The definition of a risk is a material threat that could affect our business objectives. Risks are identified at both departmental and company levels. A company wide tool is used to monitor, mitigate and adapt to all risks. Each risk is allocated a probability of occurrence in one of 6 bands, ranging from: 0%-4% (highly unlikely) to >85% (certain to occur).

Each risk is also evaluated for severity of impact individually in the areas of Finance, Customer and reputation giving a summary severity impact score.

Severity of impact on: Company finances
Ability to provide ATC service
Company reputation
} Overall severity impact score

After a probability and severity impact has been completed, a treatment and mitigation plan is generated to reduce the risk for those risks that are deemed to require further treatment.

High severity risks are scrutinised at Board level.

Ten individual risks related to climate change have been identified, and the severity and probability of each risk evaluated (see Table 1). This determines the level of monitoring and mitigation actions required.

Quantification

The severity of risks is quantified using three parameters which are added together to give an overall score. These parameters measure Impact on the reputation of the company, Customer Impact and Financial Impact (see below).

Reputational Impact (Most expected case scenario)

Rating	Severity/Impact	Evaluation Criteria
0	Insignificant	Junior Management Accountability Little or no stakeholder involvement – Reported to Middle Management Would not feature in the media
1	Minimum	Middle Management Accountability Stakeholders would/could include Senior Management/GMs Internal or local geographical impact Media attention – Remote (single local article) or no media attention
2	Moderate	Senior Management Accountability Stakeholders would/could include GM/Executive, Customers, TUs Industry or National geographical impact Media attention – local newspapers, Industry journal, trade publications, PPrune
3	Major	GM Accountability Stakeholders would/could include – Executive/Board/Regulator/Customers/TUs External impacts (e.g. general public talking about NATS) International geographical impact Media Attention - National newspaper & some TV (local & National) attention[4] –
4	Catastrophic	Executive/Board Accountability Sustained media attention at National Television & National Newspaper level[1] Stakeholders would/could include – Board/Regulator/Government/Lenders/Customers/TUs Potential for Regulatory/Government Intervention Candidate NATS top risk

[3] All the risks associated with climate change are risks to the business, which will manifest over a relatively long (strategic) timescale. The NATS Safety Management System is responsible for the management of safety risks at a tactical level, (see page 7).

[4] Corporate Communications would need to be notified of this risk as soon as it is raised

Customer Impact (Most expected case scenario)

Rating	Severity/Impact	Evaluation Criteria
0	Insignificant	Junior Management Accountability Negligible impact on; Customer & Contract penalties, Growth; Customer Satisfaction' Shareholder Value & Dividends.
1	Minimum	Middle Management Accountability Minimal impact on; Customer & Contract penalties, Growth; Customer Satisfaction' Shareholder Value & Dividends.
2	Moderate	Senior Management Accountability Some impact (short term) on; Customer & Contract penalties, Growth; Customer Satisfaction' Shareholder Value & Dividends.
3	Major	GM Accountability Serious (short/med term) impacts on; Customer & Contract penalties, Growth; Customer Satisfaction' Shareholder Value & Dividends
4	Catastrophic	Executive/Board/ Regulator Intervention Serious (sustained) impact on; Customer & Contract penalties, Growth; Customer Satisfaction' Shareholder Value & Dividends. Candidate NATS top risk

Risk Severity - Financial Impact (Most expected case scenario)

Rating	Severity/Impact	Evaluation Criteria
0	Negligible	No loss of ATC service; no cost of repair or replacement; no cost of impairment (on a £20m project); no project delay; no loss of planned resource; no loss of planned/ forecast revenue
1	<£1m	Loss of ATC service for less than 1 day; Minimum cost of repair or replacement; Minimum cost of impairment (on a £20m project); Minimum project delay (up to 60 days delay); Minimum loss of planned resource; Minimum loss of planned/ forecast revenue
2	£1-5m	Loss of ATC service for 1-3 days; Moderate cost of repair or replacement; Moderate cost of impairment (on a £20m project); Moderate project delay (60 - 120 days delay); Moderate loss of planned resource; Moderate loss of planned/forecast revenue
3	£5-£15m	Loss of ATC service for 3-10 days; Major cost of repair or replacement; Major cost of impairment (on 1 £20m project); Major project delay (120 - 365 days delay); Major loss of planned resource; Major loss of planned/forecast revenue
4	>£15m	Sustained loss of service for more than 10 days; Significant cost of repair or replacement; Significant cost of Impairment (on 1 £20m project); Significant project delay (365+ days delay; Significant loss of planned resource; Significant loss of planned/forecast revenue

Risk Probability

The probability of a risk occurring within the stated planning horizon is determined according to the guidelines below. The longer the planning horizon, the higher the probability that a given risk will occur. The timescales over which climate change impacts will begin to manifest themselves are relatively long (50-100 years).

Risk Percentage	Description	Evaluation Criteria
0%-4%	Very Remote	Less than a 5% chance of the event occurring within the applicable planning *horizon**. Event will only occur in exceptional circumstances or following a combination of very unlikely events Existing controls[5] are strong in mitigating the probability of occurrence e.g. snow in the Sahara
5%-14%	Remote	Between a 5% and 14% chance of the event occurring within the applicable planning *horizon*. Not expected to occur, but event could happen under rare circumstances. Existing controls are robust in mitigating the probability of occurrence e.g. snow in Gibraltar
15%-29%	Unlikely	Between a 15% and 29% chance of the event occurring within the applicable planning *horizon*. Small likelihood, but event could occur Existing controls are adequate in mitigating the probability occurrence. e.g. snow in Madrid
30%-49%	Likely	Between a 30% and 49% chance of the event occurring within the applicable planning *horizon*. Event is likely to occur Existing controls are reasonable but could be improved in mitigating the probability of occurrence e.g. Snow in London in winter
50%-84%	Very Likely	Between a 50% and 84% chance of the event occurring within the applicable planning *horizon*. Event is very likely to occur Existing controls are inadequate and should be improved in mitigating the probability of occurrence e.g. Snow in Edinburgh in winter
>84%	Almost Certain	Almost certain to occur in current circumstances Consider – this may now need to be treated as an issue for immediate action Existing controls are unsatisfactory in mitigating probability of occurrence If we do keep this on the RAMP then the likelihood must be reduced by specific, immediate treatment actions e.g. winter snow in the Alps

* Planning horizon could include a Business Planning year, Control Period (5 years), Project Duration or milestone, or be an ongoing risk without a known end date.

[5] Existing controls form part of 'day job' activities, governance procedures, management of systems & processes

6. Uncertainties and assumptions

Assumptions

Projections of long term changes to weather patterns have used the UK Climate Projections 09 (UKCP09) dataset provided by DEFRA. UKCP09 gives mean, min and max values. It does not give an indication on the frequency of events.

NATS' design envelopes for assets (airspace, systems and buildings) are based on the mean – There is an acceptance that there could be short breaches of these design envelopes and we have contingency plans in place to deal with them. All buildings are constructed in accordance with Chartered Institution of Building Services Engineers (CIBSE) guidelines.

Uncertainties

There are naturally uncertainties about the reliability and accuracy of climate change data. It is assumed that the impacts of climate change will take effect gradually. NATS has robust operational contingency measures designed to manage relatively large short term fluctuations in weather. Hence the approach is to put in place strategic actions supported by comprehensive operational contingency plans to deal with unexpected events.

The reaction of government and regulators to climate change are also significant uncertainties. It is possible that the reaction may in some cases be to impose restrictions on the number of flights allowed. This poses a risk to NATS business in that it would severely impact revenue and would negate any prospect of growth.

The Impact of Climate Change on UK Air Traffic Patterns

NATS commissioned a study by Environmental Resources Management Limited (ERM), in partnership with the Met Office and the Centre for Aviation Transport and the Environment (CATE) at Manchester Metropolitan University. The report summarised the state-of-the-art estimates for the following directly affected variables:

- the North Atlantic jet streams;
- severe convection and thunderstorm activity;
- the frequency and track of mid latitude cyclones;
- the prevailing wind patterns at airports;
- winter and summer temperatures;
- the incidence of frost and snow;
- fog frequency;
- precipitation events leading to flooding; and
- the sea level at vulnerable airports

It also described the likely impact of indirect effects including changes in the choice of travel destination for tourists and changes in food production (with implications for freight traffic). The study quantified the likely changes and provided upper and lower bounds on the estimates.

The findings of the report were discussed in a workshop with representatives from key areas in NATS such as Development & Investment, Environment and Community Affairs, Network Management and Forecasting. It identified that whilst many of the likely changes could be dealt with tactically, in the same manner as NATS deals with weather on a day-to-day tactical basis today, there are key areas such as changes in travel destinations, changes to the North Atlantic jet streams that should be further researched and mitigated.

As NATS is dependent on external as well as internal drivers, it is important to consider the impact of climate change on our customers[6] (and *their* customers' behaviour) in order to understand subsequent knock on effect this may have on NATS.

[6] Primarily Commercial Air Transport

In order to determine what future changes in weather patterns would mean to us, this paper also looked at the influence of current weather and travel patterns on current operations. By recognising travel behavioural issues, and changes in attitude which affect the decisions people make with regard to both the environment and their travel patterns (e.g. choice of holiday destination) are better understood. This allows more informed analysis of how these behavioural issues may impact on our business.
NATS has procedures in place to deal with each risk occurring, no matter how low the probability.

Table 1 shows the list of possible climate change related risks that have been identified. Each risk has been plotted on a Risk Assessment & Management Plan (RAMP) diagram for 25, 50 and 100 year horizons (Figure 4 to Figure 6).

7. Identifying current and future risks due to climate change

	Impact/Risks on functions					
Event	**ATC procedures/ operations**	**ATC systems**	**Buildings**	**Remote sites**	**Business**	**People**
1.Thunderstorms, lightning (more frequent & more severe)	As per today. Increased delays, track mileage. Traffic avoidance of weather system + temporary closure of airports affected (<2 hours).	Protection adequate as extant	Protection adequate as extant	Protection adequate as extant	Weather delays are not attributable, but impact on customers.	n/a
2.High winds (inc gales/ storms/Hurricanes/ Tornados)	Weather avoidance, delays, track mileage increases.	Damage or temporary disruption to systems	Damage to buildings	Damage to remote sites	Costs of damage to assets, down-time & repair.	Staff unable to attend work. Staff at work exceed hours. Leads to short-staffing delays.
3 Snow, sleet, blizzard, ice	Dangerous flying & takeoff/ landing conditions resulting in closure/reduction in capacity of airports. Reduction of capacity of ATC sectors.	Damage or temporary disruption to systems	Damage /Unable to access building	Unable to access remote sites for repair or maintenance work. Snow/ice damaging/ disrupting normal operation of systems	Costs of down-time, reductions in capacity	Staff unable to attend work. Staff at work exceed hours. Leads to short-staffing delays.
4 Freezing fog/ in-flight icing	Dangerous flying & takeoff landing conditions resulting in closure/reduction in capacity of airports. Reduction of capacity of ATC sectors.	n/a	n/a	n/a	Weather delays are not attributable, but impact on customers.	Staff unable to attend work. Staff at work exceed hours. Leads to short-staffing delays.
5 Rainfall/Flooding	Weather avoidance, delays, track mileage increases. Disruption at airports	Damage or temporary disruption to systems	Damage /Unable to access building	Damage /Unable to access remote sites	Costs of damage to assets, down-time & repair.	Staff unable to attend work. Staff at work exceed hours. Leads to short-staffing delays.
6 Summer mean Temp rise.	Impact on transition levels & min holding levels. Degraded aircraft climb performance.	n/a	Subsidence damage	Subsidence damage	Costs of damage to assets, down-time & repair.	n/a
7 Sea level rise	Flooding of ATC centres (Swanwick is 40ft, Prestwick is 65ft amsl). ATC operations cease due to flooding.	Damage to electrical systems & computers rendering ATC systems inoperative.	Flood damage. Coastal erosion.	Flood damage. Coastal erosion.	Cost of damage to buildings & assets. Cost of centre relocation to higher ground.	n/a
8 Jet stream movement	As per today. Adaptation to changing flow patterns & sector loading	n/a	n/a	n/a	Impact on revenue if traffic permanently displaced.	n/a
9 Public perception of travel	n/a	n/a	n/a	n/a	Reduction numbers of people flying, hence reduction in flights & reduction in revenue.	Staff motivation & retention impacted.
10 Environmental protest	n/a	n/a	Protests & vandalism at buildings & sites.	Vandalism at remote site installations.	Direct action against the aviation community, NATS is targeted by environmental protestors:	Staff intimidated.
11 Restrictions on numbers of flights	n/a	n/a	n/a	n/a	Impact on revenue and growth possibilities.	n/a

Table 1 Climate change related risks.

Risks 1-6 as listed in Table 1 are weather related events which occur currently. The risk from climate change is that the frequency and severity of these occurrences increases significantly.

Sea Level rise

Measurement of sea levels over the past century has shown that levels have been rising at a mean rate of 1.8 mm per year. More recent sea level measurement by satellite, has estimated rates of 2.8 ±0.4 to 3.1 ±0.7 mm per year between 1993–2003. However from 2006 to 2010 the rate of sea level rise dropped back to levels approaching zero. Values for predicted sea level rise over the course of this century typically range from 90 to 880 mm (3.54 inches – 2.89ft), with a central value of 480 mm (1.57ft). Models of glacier mass balance (the difference between melting and accumulation of snow and ice on a glacier) give a theoretical maximum value for sea level rise in the current century of 2 metres (and a "more plausible" one of 0.8 metres), based on limitations on how quickly glaciers can melt. The UKPC09 predictions for relative sea level, indicate a rise of less than 0.7m rise in sea levels by 2100 (see Figure 3 below, which shows the 95/50/5% probability for the high emissions scenario – sea levels are very unlikely to be higher than the 95% probability levels.)

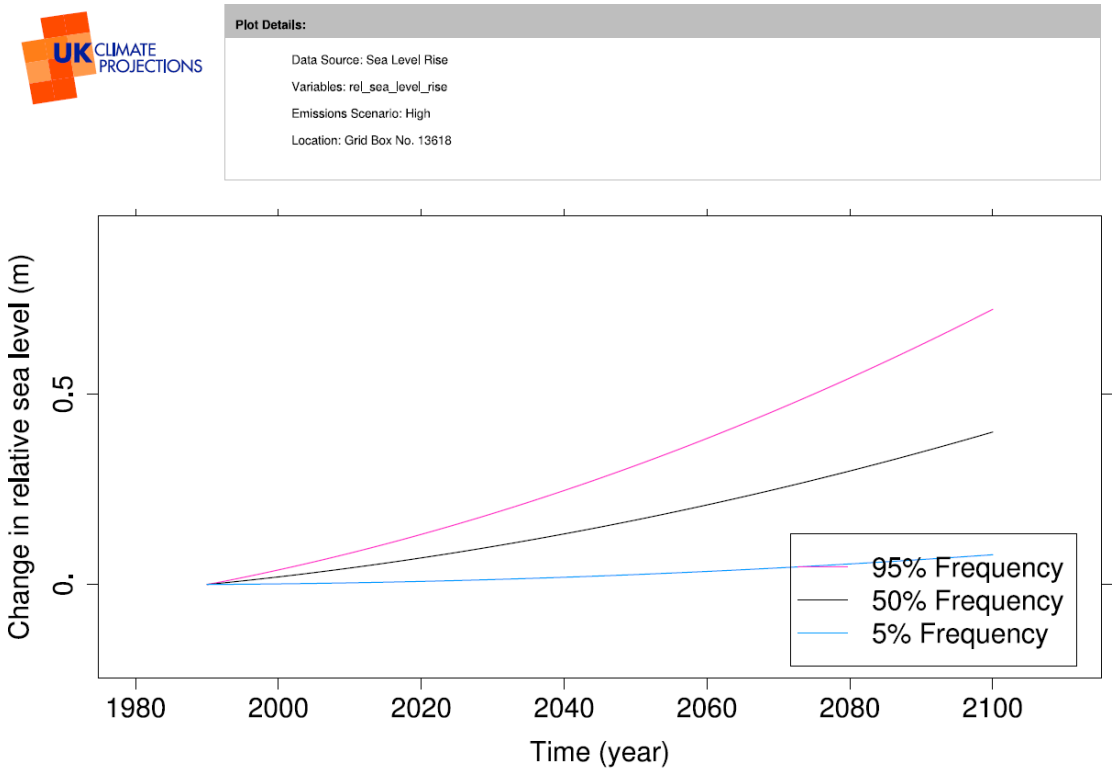


Figure 3 UKCP09 Sea level rise prediction (Prestwick)

NATS ATC Centres

NATS main Air Traffic Control Centres are at elevations of 11m (36ft) and 20m (65ft) above mean sea level. Based on the range of predictions above, a worst case scenario of a 2m (6.6ft) rise in sea level by 2080 has been assumed. (note The main ATC centres will not be impacted by a sea level rise of this magnitude. The design life of the centres is 40-50 years. The situation will be re-evaluated when the centres are due to be replaced. If at this point rising sea level present a threat, they will be relocated to higher ground.

NATS Remote Sites

NATS has numerous remote sites across the UK. These are primarily required to provide the Communications, Navigation & Surveillance (CNS) infrastructure necessary to support the ATC operation. Most are situated at hill-top locations since these provide the best coverage for CNS systems. These locations will not be affected by sea level rises. Some remote sites are located close to the coast, near to sea level, especially navigation facilities associated with costal airports. There are 21 airports in the UK at elevations less than 20ft (6m) above mean seal level, these are listed in **Table 2**. The threat of rising sea level and costal erosion will be assessed at each remote site asset annually, during routine maintenance. If there is any threat to the asset, appropriate action will be taken, including possible relocation of the asset.

Airport	Elevation (ft amsl)
Barra	0
Caernarfon	0
Beverley	3
Shoreham	7
Fenland	8
Newtownards	9
Eday	10
Sandtoft	11
Brough	12
Lydd	12
Belfast City	15
Bellarena	15
Glenforsa	15
Pembrey	15
Dundee	17
London City	17
North Coates	17
Benbecula	19
Sumburgh	19
Brieghton	20
Oban	20

Table 2 Airports below 20ft amsl

Mean Temperature

Changes in mean temperature do not present a threat. For example NATS buildings and assets are constructed to European standards, and there are many examples of countries within Europe using the same standards, where mean temperatures are currently much higher (and also much lower) than in the UK. Hence we can be confident that it is well within NATS capabilities to adapt to changes in mean temperature.

Changes to the Jet Stream

The position and strength of the Northern Hemisphere polar jet front (commonly known as the "jet stream") is important for aviation for a number of reasons. The position of the jet stream moves daily. It is sought out by east-bound transatlantic flights due to favourable tail winds (100mph+), and avoided by the west-bound flights due to the headwinds. The North Atlantic route structure is varied each day according to the position of the jet stream, so that flights can make best advantage of the winds. An average pole-ward shift of the jet will make a difference to route plans and flight times, However, the scale of both the observed and projected future changes in stream jet latitude is small in the period considered. An average pole-ward shift of no more than around 1 degree per decade is expected. This annual average shift does mask more significant changes within a year, chiefly in late autumn and winter. The uncertainty surrounding changes in the strength of the jet stream, and subsequent changes in weather patterns over Europe mean that there is no clear consensus on the change expected. However, although uncertainty is high, there is little evidence that any change will be large in scale, and this is supported by the fact that the storm climate in the North Atlantic has not changed significantly in the last 100 years, whilst other climate change indicators have shown marked trends. In the longer term, the pole-ward shift of the polar jet stream could mean fewer eastbound flights using UK airspace, as they utilise the more northerly jet stream. This could have adverse revenue implications for NATS.

Environmental Protest

NATS could become a target for environmental protestors. Recent publicity during the Volcanic Ash crisis raised the profile of NATS in terms of its association with aviation and the environment. If environmental groups intensify direct action against the aviation community, the risk to NATS from such activity could increase.

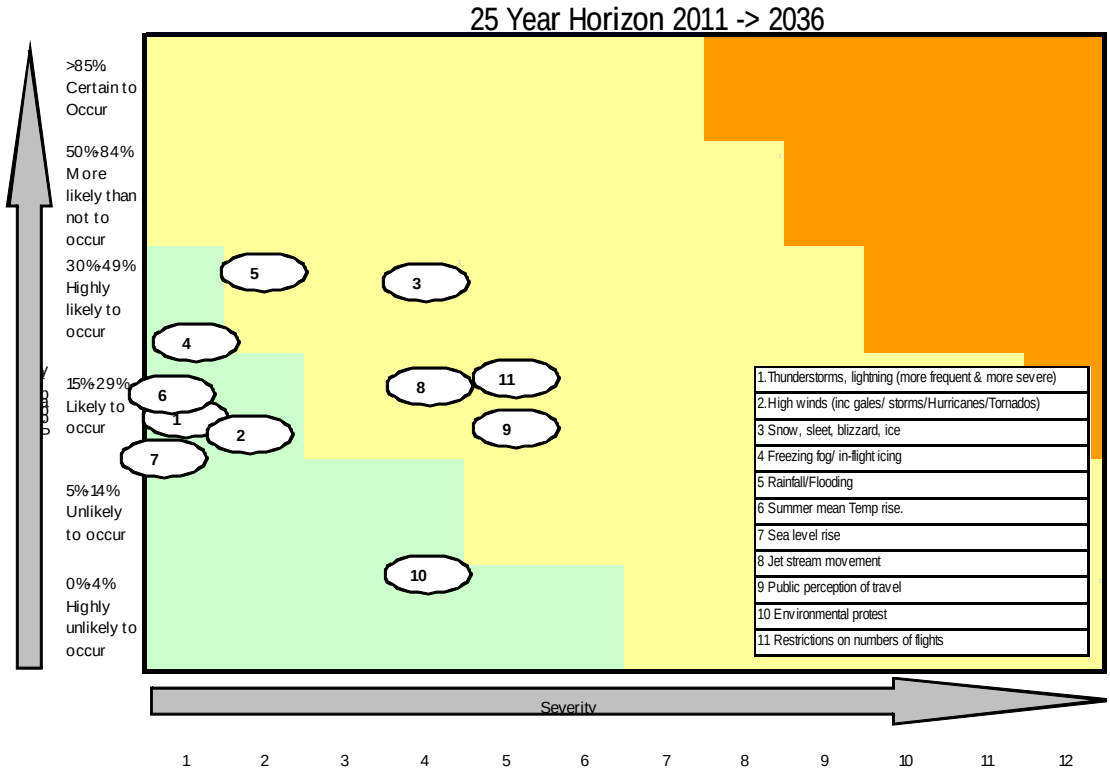


Figure 4 Risk Assessment & Management Plan (RAMP) 25 year horizon

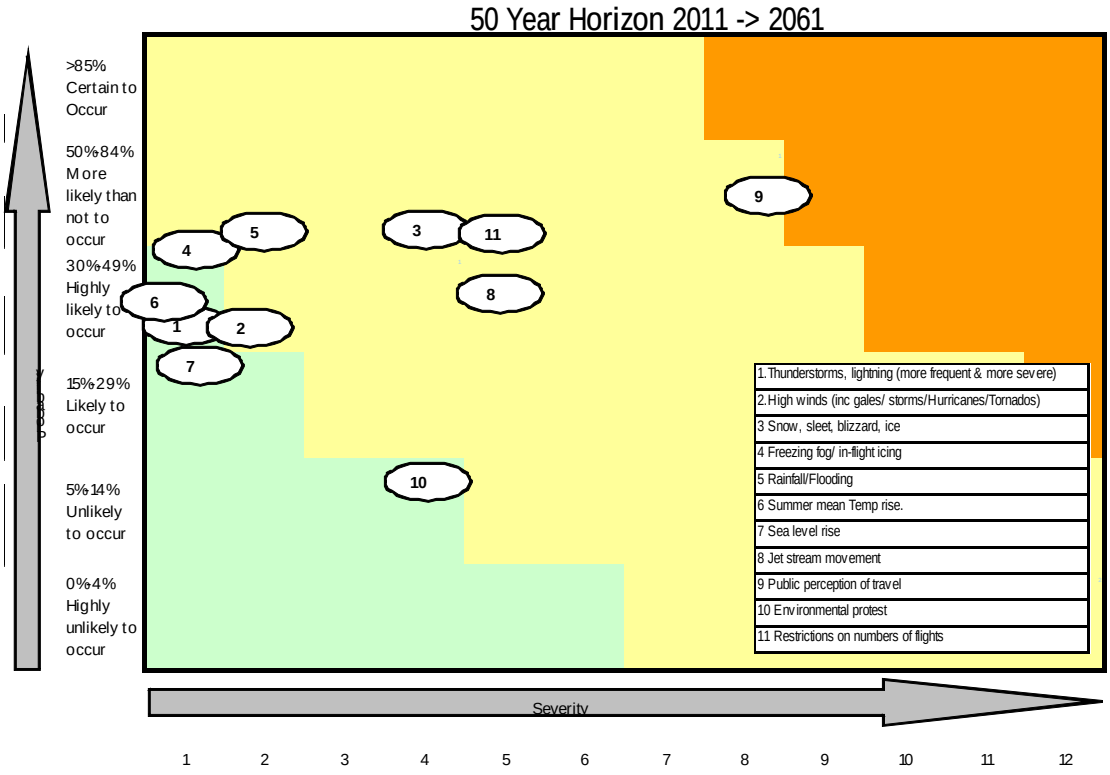


Figure 5 RAMP diagram 50 year horizon

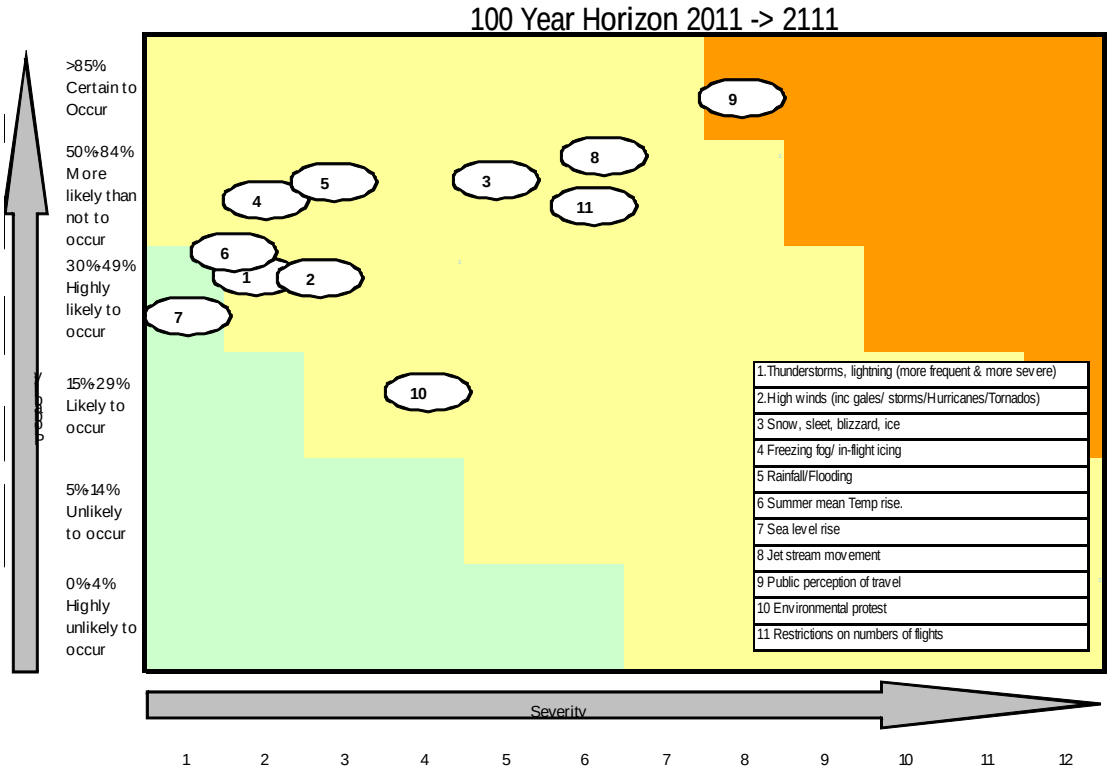


Figure 6 RAMP diagram 100 year horizon

From the RAMP analysis shown in Figure 4 to Figure 6 the following risks were identified as being the most significant threats to NATS business:

- Snow, sleet, blizzard, ice;
- Jet stream movement;
- change in the Public perception of travel;
- Externally imposed restrictions on numbers of flights

These risks have been examined in more detail in Table 3

Climate variable	Business Function	Primary impact of climate variable (e.g. health)	Threshold(s) above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Potential impacts on organisation and stakeholders	Propose action to mitigate impact	Timescale
3. Snow, sleet, blizzard, ice.	Operation of ATM Systems & delivery of service	Access by staff to centres. Resilience of systems & remote site equipment to prolonged snow & ice. Access to remote sites for maintenance.	Typically> 30cm of snow. Severe icing at ground level. Procedures already exist to respond to such circumstances, such as using LandRovers to shuttle staff to work and providing hotel accommodation close to work for key personnel.	Low – if severe blizzard & snow conditions become a regular occurrence NATS will equip accordingly to deal with it. (As is currently the case in Canada, Sweden etc)	If the threshold is exceeded, NATS is able to provide partial service even with reduced staffing. The challenge facing airports in keeping the runways taxiways & roads clear is far greater, hence usually the general transport infrastructure is more affected such that very few aircraft would be flying (and few passengers would be able to get to the airports).	Monitor and ensure that operating specifications of future systems address this issue	50 years.
	Financial (Revenue)	Financial impact of loss of revenue for extended periods of weeks - months during which traffic volume severely reduced.	>2 weeks per year	Medium	Impact on revenues and hence on financial security could be significant.	Encourage equipage by NATS and its partner organisations (e.g. airport operators) to minimize the impact of severe snow & ice	50 years.
8. Jet stream movement	Financial (Revenue)	If the movement of the jet stream is enough such that the preferred (most efficient) routing for transatlantic flights is further north, such that routes are moved outside of NATS' controlled airspace. This will impact NATS revenue.	3 degrees of shift. (in average latitude)	Estimates are that this threshold will not be reached within 100 years.	Impact on revenues and hence on financial security could be significant.	Adapt pricing for transatlantic flights so that NATS airspace becomes a more cost-effective alternative.	50 years.
9. Public perception of travel	Financial (Revenue)	Customer's behaviours/choices. Choosing to fly less frequently and shorter flights.	This issue could fundamentally affect the demand for air travel. Particularly if twinned with rising fuel prices (it is recognised that this is not a climate change effect) the perception that air travel is environmentally damaging could result in a sharp down-turn in the demand for air travel.	Medium. It is difficult to predict with any certainty public attitudes decades in the future. However children now at school are far more sensitive to environmental issues. As they progress to adulthood it is not hard to imagine scenarios where a large-scale shift in attitude to air travel could take place.	This would result in a reduction in demand. The impact of which could be significant on revenues and hence on the financial security of the company.	Education & publicity in conjunction with airlines	50 years.
11. Restrictions on numbers of flights	Financial (Revenue)	Financial. NATS revenue would be capped by the restriction.	Any limit which restricts numbers of flights below the numbers currently flying, would affect the organisation.	Medium. Restrictions via various mechanisms could be introduced. E.g. carbon trading, carbon allowances, government or EU imposed caps/quotas	This would severely restrict NATS revenue. The only possibility of growth would be via the unregulated business.	Increase proportion of unregulated business. Diversify into other markets.	30 years

Table 3 Most significant risks.

It can be seen from the results of Figure 4 to Figure 6 and Table 3, that NATS is well positioned to adapt to those climate change effects which manifest themselves in meteorological phenomenon. NATS routinely adapts its operations daily to adjust to adverse weather effects, hence this capability is built into the organisation. However the effects which have been identified as posing a more fundamental risk, are those climate change effects which could undermine the financial health of the company. These potential threats present a much greater challenge to adapt to. If demand and revenue reduce in what has traditionally been the core business for NATS, then the only alternative would be for NATS to diversify by applying its many world-class capabilities in other markets.

8. Barriers to implementing adaptation programme

Financial barriers – the cost of implementing the adaptive action plan could increase NATS cost to the extent that it would be impossible to absorb them. Hence it would be necessary to pass the cost increases on by increasing prices. If restrictions in the number of flights also occurred the loss of revenue, coupled with increased costs would present a double financial impact on the company.

Physical – any large scale relocation or redesign of buildings / assets would require planning approvals; long lead times. These major works would require effective planning and management to avoid service delivery impacts.

9. Interdependencies

Key Suppliers

NATS operations are dependent on the services of several key suppliers. The continuing smooth operation of NATS' day-to-day operations are reliant on the ability of our key suppliers to deliver uninterrupted essential services. Our supplier contracts ensure that all suppliers and sub-contractors have sufficient plans or contingency to adapt to climate change.
The suppliers of the following services are considered essential:

- Telecoms
- Electricity
- Gas
- Water
- Sewage
- Waste management
- IT services

Regulation

NATS business is strictly regulated and hence there is a dependency on the Regulator and Government. There is a risk that (motivated by climate change) additional restrictions could be imposed on air traffic which would increase operating costs and/or restrict the volume of air traffic. This will in turn threaten NATS business and profitability.

Key Interfaces

The interfaces that NATS has with Airports, Airlines and adjacent Air Navigation Service Providers (ANSPs), also have a significant influence on how efficiently the business can operate.

Airports The efficient operation of airports dictates the supply of aircraft into the air traffic control system. As can be seen by "The Big Freeze of 2010" Case Study (page 26) –the Airports' ability to cope with perturbations to the normal meteorological conditions, is a major constraint on the air traffic system. The logistical challenges faced by airports in dealing with severe weather events are greater than those faced by Air traffic service providers such as NATS. Hence airport operations are usually the first point of failure. Often the ATC operation (airport control towers and enroute control centres) will remain operational while airports are closed due to severe weather.

Airlines NATS business is driven by the demands of the airlines, who are our primary customers. When an airline changes its flight schedules or moves its operation from one airport to another, NATS has to react and accommodate the changed traffic patterns. This can often have far reaching effects such as changing the staffing levels on each sector and requiring changes to airspace design. If climate change has an influence on airlines businesses, and where they fly, this will have an inevitable knock-on effect on NATS. In turn NATS will ensure that the services we offer to our airline customers remain resilient to the manifestations of climate change. This will guarantee that NATS will continue to provide a safe, expeditious and environmentally efficient air traffic service.

Adjacent Nations' ANSPs The airspace operated by NATS has borders with the ANSPs of Canada, Iceland, Norway, Denmark, Netherlands, Belgium, Eurocontrol, France, Spain, Portugal and Ireland. Air traffic controllers operating the bordering sectors are in regular communication with the controllers of the adjacent ANSPs. NATS systems have to communicate seamlessly with those of all the adjacent ANSPs.
The efficient delivery of air traffic into UK airspace is dictated by the adjacent ANSP. Hence cross-border arrangements are very important since without well-defined procedures the adjacent ANSPs have the capacity to greatly complicate the task of NATS ATC.

10. Opportunities

While there may be some potential opportunities presented by a changing climate, it should be emphasised that the risks posed by climate change are far greater than any potential benefits. It is unlikely that NATS would achieve any net benefit from climate change. Some possible opportunities are identified below.

Optimisation of ATC to minimize aviation emissions

NATS has many independent work stream that are working to reduce emissions and help reduce the environmental impact of aviation. NATS is recognised as a world leader in the modelling of aircraft emissions, and in airspace & procedure design to minimise emissions. There may be the opportunity to market this expertise internationally to other Air Navigation Service Providers.

Change to patterns of air traffic

Climate change may result in changes in the patterns of air traffic. This could either benefit or disadvantage NATS.

11. Report and review

The adaptation programme is expected to reduce the residual risk to NATS from climate change. The impact of climate change is one of many important variables that is considered in NATS strategic and business planning processes. However the adaptation programme has raised awareness of the issues. The adaptation programme ensures that climate change risks are considered as part of our normal business processes.

NATS has a comprehensive performance regime that monitors service quality (delays), safety, cost and environmental impacts. Specific metrics focus on the impact of weather on aircraft delays and provide a valuable dataset e.g. Weather related impacts on flight delays. The causes of interruption of equipment service are also tracked.

Assets

Asset design envelopes provide a clear baseline for determining thresholds. Climate change impacts which start to approach these thresholds will serve as alarm triggers. Incidents affecting assets that are due to climate changes are monitored – the frequency of such events will provide a base set of data for considering the need for additional action.

Ongoing Reporting

All risks will be monitored regularly. Those risks which affect assets will be monitored as part of the asset management process, this will be via annual reviews. A separate review which will serve as a follow-up to this report should be undertaken at least every 10 years. This will serve to monitor progress of actual events versus predictions, and give a periodic re-evaluation of the climate change risks.

The approach taken by NATS to climate change adaptation is proactive and builds in flexibility. This enables the action required to be adapted to suit the challenge, as risks manifest themselves.

References

1. The Impact of Climate Change on UK traffic Patterns. Ioannis Chrysostomidis, Callum Thomas et al. March 2010
2. Climate Change: Impact on NATS. Chris Porter, January 2009

Case Study – The Big Freeze of 2010

This case study serves as an example of how NATS responds to unusual events. In this instance the perturbation to normal operations was caused by an extreme weather situation, however NATS also regularly practices response to events such as terrorist attack, volcanic eruptions (causing ash clouds), and a range of weather related phenomenon.

Weather Event

From 22nd November 2010 to 18th December 2010 heavy snowfalls and record low temperatures brought, travel chaos and disruption to Great Britain and Ireland.

This cold snap was the UK's earliest widespread winter snowfall since 1993 with snow falling as early as 24 November across Northumberland and North Yorkshire. A maximum snow depth of 76 cm (30 inches) was recorded on 1 December in the Peak District and Sheffield. Scotland and Northern England were most severely affected. On 9 December temperatures recovered across much of the UK, causing a partial thaw.

Later, on Thursday 16 December a cold front reintroduced a cold, arctic air-stream. This cold spell brought further snow and ice chaos back to the United Kingdom with Southern England, Wales and Northern Ireland bearing the brunt of the wintry conditions. This led to severe disruption to the road and rail network with several airports being closed including London Heathrow airport for a time. Several local temperature records were broken including a new record low for Northern Ireland of -18.7 °C recorded at Castlederg on the 23 December 2010.

NATS Response

There was much disruption to air travel due to the widespread closure of many major airports which were not equipped to cope with the large quantities of snow[7]. At no point was there any disruption or loss of service to Air Traffic Control. The main challenge to NATS in keeping the ATC service available was ensuring that staff could reach work. This was achieved by providing accommodation for key staff at hotels within walking distance of their workplace (e.g. at the airports) and also by using Land-Rovers to shuttle key operational staff between home & work. All key equipment (radar systems and radio communication systems) remained operational throughout the period, despite record breaking low temperatures.

[7] Keeping the airport operating, including the removal of snow is the responsibility of the airport operator at each airport.