



Defence in a changing climate

Hardly a day goes by without some new warning of the effects of global warming. However, the global defence community is at an early stage in assessing the effects of climate change on operations and procurement.

This brief overview is intended to encourage further consideration by the Ministry of Defence of the implications of climate change. It is not a comprehensive study. It is simply meant to stimulate thoughts and ideas around the issues that may require more in-depth analysis.

DEFENCE SCIENTIFIC ADVISORY COUNCIL

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The climate is changing. Over the past century, global average temperatures have risen by 0.6° C. Sea level is rising by 10-20 cm/century.

Average temperatures in the UK could increase by between 1.0 and 2.4° C by 2050. But this average change doesn't tell the full story. A 1° C change in average temperatures can give rise to 8° C changes in the maximum.

Global warming is implicated in recent changes in weather patterns. Extreme events – floods, drought, storms and 'record' temperatures – are more frequent.

Some recent trends and weather patterns presage conditions that could become more frequent in future:

- The summer of 2003 broke temperature records over continental Europe, leading to 15,000 more deaths than usual in France alone.
- The Thames Barrier now operates much more often than originally planned. There are already plans to build a new barrier to cope with higher sea levels and storm surges.
- The number of Category 4 and 5 hurricanes around the world has almost doubled in 30 years.
- 10 of the warmest years on record have been since 1990.

Such patterns will affect when, where and how the defence community has to operate. Defence planners have to prepare for even more severe changes in the future.

Climate change already poses new challenges for equipment, people, buildings and structures, and logistics and operations. Today's procurement decisions influence operational capability for the next half century.

What will it affect?

- Geopolitics – climate change may create future conflicts influencing when and where the defence community is called upon for peace keeping operations.
- Equipment – procurement has to ensure that hardware is fit for purpose in new climate scenarios.
- People – the armed forces will operate in demanding conditions driven by global warming.
- Estates – buildings and other infrastructure must adapt to mitigate the effects of climate change.
- Logistics and operations – when and where the armed forces operate will change supply chains and what they have to deliver.

Geopolitics

There are already disputes over resources, such as water, where climate change will create further tension and possibly conflict. This may require the involvement of the armed forces to help to end conflicts. Recent conflicts have shown that local disputes can create safe havens for terrorists. And many of today's friction points, such as the Middle East, are especially vulnerable to the effects of global warming.

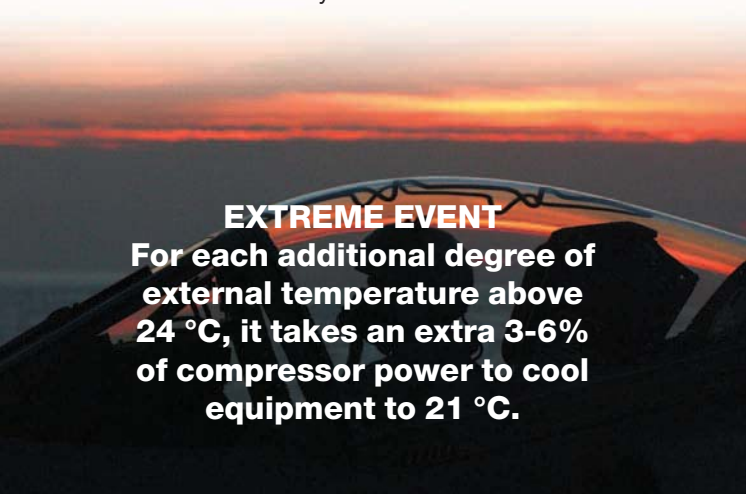
Equipment

It can take a decade or more to specify, design and build equipment that will remain in service for as much as 50 years. Forces will find themselves using equipment specified today in very different weather conditions. Procurement decisions have to anticipate these changes.

For example, electronic systems – especially commercial, off-the-shelf electronics – are sensitive to temperature and humidity. We may have to change the specifications for cooling electronics.

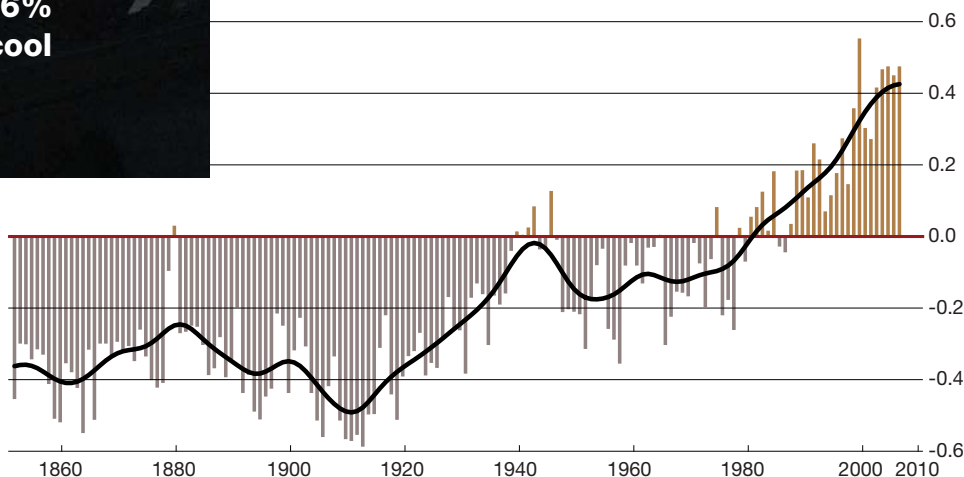
Other challenges for equipment could include:

- Lubricants and cooling systems for engines are already approaching their limits.



EXTREME EVENT
For each additional degree of external temperature above 24 °C, it takes an extra 3-6% of compressor power to cool equipment to 21 °C.

Global Temperature Record

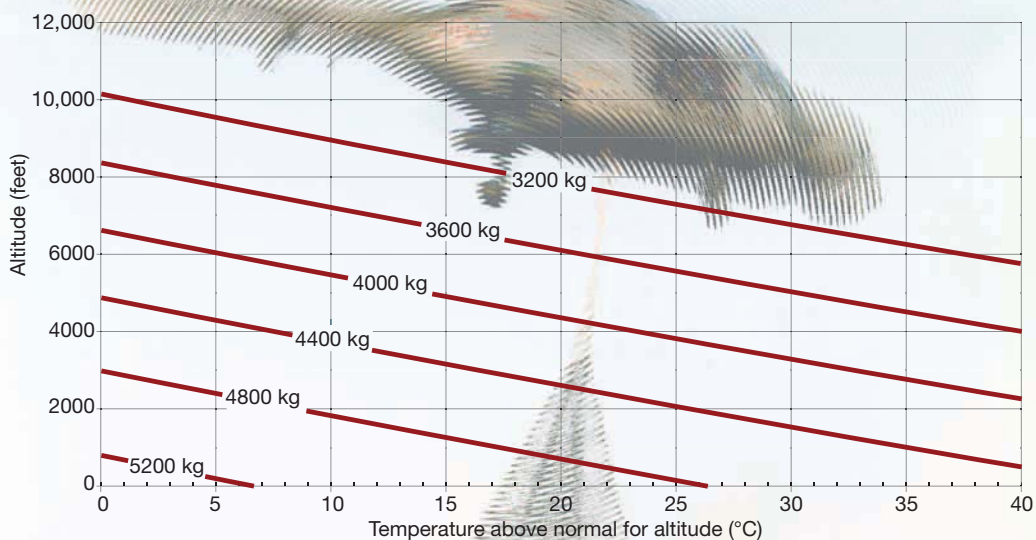


The time series shows the combined global land and marine surface temperature record from 1850 to 2005. The year 2005 was equal second warmest on record, exceeded by 1998. This time series is being compiled jointly by the Climatic Research Unit and the UK Met. Office Hadley Centre.

<http://www.cru.uea.ac.uk/cru/info/>



How much a helicopter can lift



A helicopter's carrying capacity falls steadily the higher it flies but also with higher ambient temperatures.

If climate change leads to more days with higher temperatures, that will have a direct impact on operations, and possibly on the number of helicopters needed to supply troops.

- Hotter weather may mean temperature controlled transportation and storage for complex munitions.
- Sensor systems now used to monitor the humidity and temperature of equipment and supplies may not be adequate.
- Higher temperatures reduce air density and limit aircraft operations. The power generated by engines and the lift generated by wings and rotors falls as the temperature rises.
- Clothing and equipment must change for operations in changed weather patterns
- Ocean temperatures, and murkier waters, could influence operating regimes for submarines.

People

Temperature and humidity affect how well we perform many tasks. Temperature extremes reduce the effectiveness of troops.

Work on *human factors* will be important in understanding how changing weather patterns will affect troops and their clothing requirements, for example. Key issues include:

- The geographical distribution of transmissible diseases changes the medical countermeasures and treatment policies required for operations.
- Changing activity of pests and disease vectors affect the viability of operations.
- Idiosyncratic physiological responses to extremes of temperature make it important to identify susceptible individuals, especially prior to rapid-response operations.
- Training must be developed to prepare troops for greater environmental extremes.
- Climate factors could affect how people react to exposure to chemical weapons.



EXTREME EVENT
Every 1°C increase in air temperature typically reduces the operating height of a helicopter by 100 feet. An extreme event could wipe 1000 feet off the flight ceiling.

Estates

The defence community contributes to climate change through energy use. Its estates, and other activities, will have to find more efficient ways of using energy.

Challenges for estates:

- Runways that become unstable as tarmac softens and buildings that cannot withstand the pressures of high winds will require revised specifications.
- Decreased durability and performance of materials will affect maintenance and facilities management.
- Rising sea levels and possible storm surges will affect ports and coastal training areas.



Logistics and operations

Defence depends on effective logistics and the ability to move people, equipment and supplies. The frequency of operations may increase, both as a result of severe weather events requiring humanitarian support, for example, and due to possible climate induced conflicts. Climate change will influence what needs to be moved around and the equipment needed to move it. To pick just one obvious example, troops operating in hot climates need more water.

Challenges for defence logistics:

- Changed weather patterns will affect the movement and storage of drugs, food and other supplies.

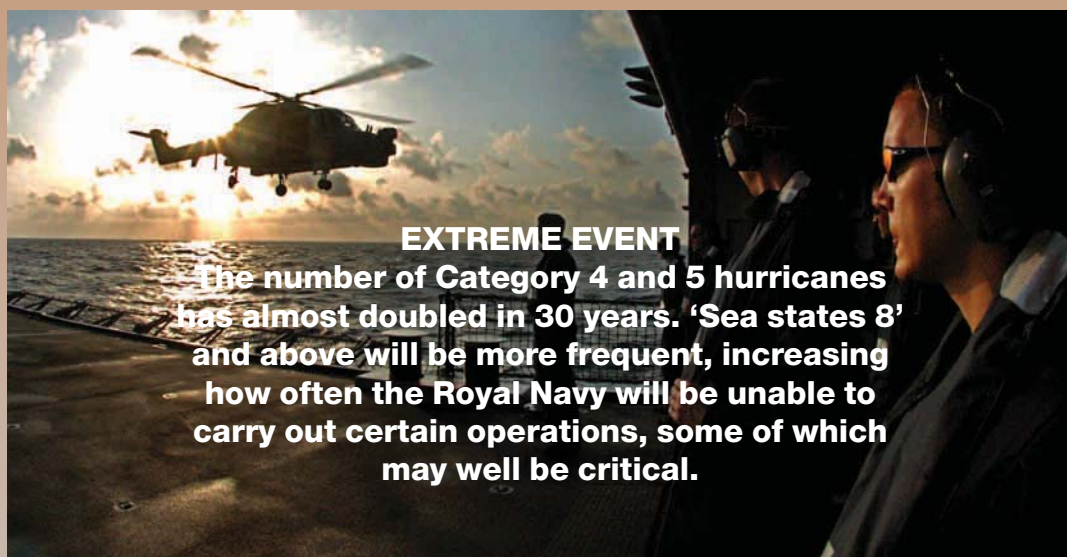
The MoD and climate research

The Ministry of Defence has supported the collection of much of the evidence for climate change, through its funding of the Met Office and the research of the Hadley Centre for Climate Prediction and Research. The Hadley Centre is responsible for monitoring the climate, globally and nationally, understanding the climate system, predicting how the climate might change in future, and attributing recent changes to specific causes. The centre makes its results and data freely available. The Met Office has one of the most powerful supercomputers in the UK, a valuable tool in modelling the climate.

At the request of the Chief Scientific Advisor to the MoD, the Defence Scientific Advisory Council (DSAC) carried out an informal scoping exercise to begin to investigate the extent to which climate change could affect the UK's defence community. DSAC then asked a small group of experts to draw on their experience and to offer advice on where the MoD might need to respond in the short- and medium-term.

Where next?

This document is, as we say at the beginning, a brief introduction to the challenges that climate change could pose to defence. Surprisingly, while there are many analyses of how climate change could influence various sectors of the economy, there is very little publicly available material on how it could affect defence. Drawing on strategic guidance, the new Defence Technology Strategy has already recognised "understanding the effect on operational environments from climate change" as one of the key challenges for MoD. DSAC looks forward to helping the MoD with its further analysis of the defence implications of climate change as they continue to consider, at all levels of their planning processes, the effects of climate change on defence activities. The next step should be to expand this review and to commission a rigorous analysis to inform the multiple aspects of defence planning.



The Defence Scientific Advisory Council (DSAC)

<http://www.dsac.mod.uk>

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