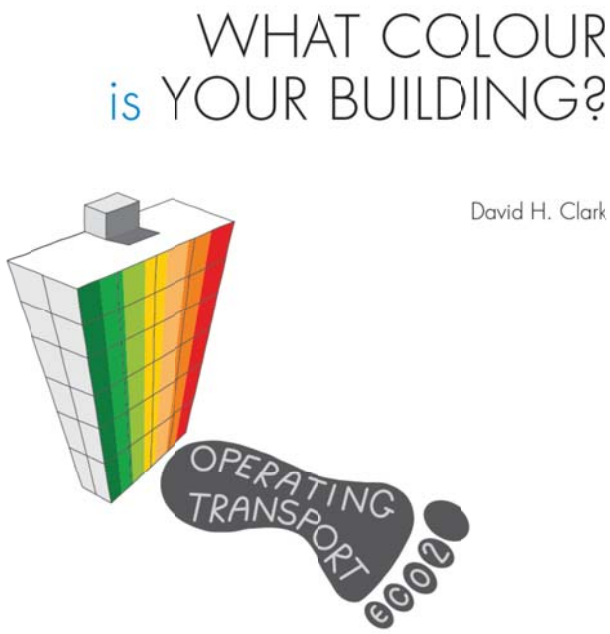
CUNDALL

Information paper – 2
Adapting buildings to climate change

Prepared by:
David Clark

A paper referenced in the book:



Issue 1.0: 29 July 2013

This information paper is one of a series of papers written during the preparation of the book **What Colour is Your Building?** (www.whatcolourisyourbuilding.com). The papers do not form part of the book and have not been peer reviewed. They provide further technical detail, analysis and information to support statements made in the book. All of the papers can be downloaded from www.wholecarbonfootprint.com.

Adapting buildings to climate change

This information paper provides an overview of climate change adaptation and on-going research on its impact on future building design and refurbishment.

1. WHAT IS ADAPTATION?

The Intergovernmental Panel on Climate Change (IPPC) defines adaptation as *'any adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects which moderates harm or exploits beneficial opportunities.'*[1]

If you accept that global warming and climate change will continue this century, even if we managed to stabilise CO_2 emissions by 2020, then it also becomes necessary to work out how to deal with changing temperatures, rainfall patterns, rising sea levels and so on. Adaptation measures can be taken at national, regional and local levels and include:

- building flood defences and raising the levels of dykes
- developing drought-tolerant crops
- choosing tree species and forestry practices less vulnerable to storms and fires
- using scarce water more efficiently
- setting aside land corridors to help species migrate
- adapting building codes to future climate conditions and extreme weather events.

Owners, planners and designers of buildings can no longer ignore the potential impact of future climate change on the built environment. These impacts can be grouped into three broad categories:

- **Thermal comfort** – keeping cool in and around buildings in summer and keeping warm in winter.
- **Construction** – maintaining structural stability, weather tightness and durability due to potential changes in soil moisture, wind speeds and wind driven rain.
- **Water** – supplying water during summer droughts and managing water during extreme rainfall and flood events.

These issues will differ across different countries and within different regions of the same country, even somewhere as relatively small as the UK. Research organisations, standards-setting bodies and the insurance industry require reliable data to inform rational responses to potential future climate change scenarios.

2. CLIMATE CHANGE PREDICTIONS

The Central England Temperature (CET) record shows that after a period of relative stability for most of the 20th century, the annual average temperature has risen by about 1°C since the 1970s. Observed trends are projected to continue and can be summarised as follows:

- Warmer, wetter winters.
- Hotter, drier summers.
- Rising sea levels.
- Increased extreme weather events.

In the UK, the UK Meteorological Office provides a series of climate projection maps for regions of the UK based on the latest scientific modelling and observations.[2] The maps provide climate predictions for three thirty year time periods (2020s, 2050s and 2080s) based on three scenarios for future greenhouse emissions (high, medium and low) and three different levels of confidence on the likelihood of the impacts (10%, 50% and 90% probability). Maps are available for summer and winter temperatures, humidity, rainfall and cloud cover.

Figure 1 shows an example map for mean summer temperature increase for the 2050s based on a medium CO_2 emissions scenario. This suggests a 2°C rise is most likely but that it could be as low as 1°C or as high as 4°C.

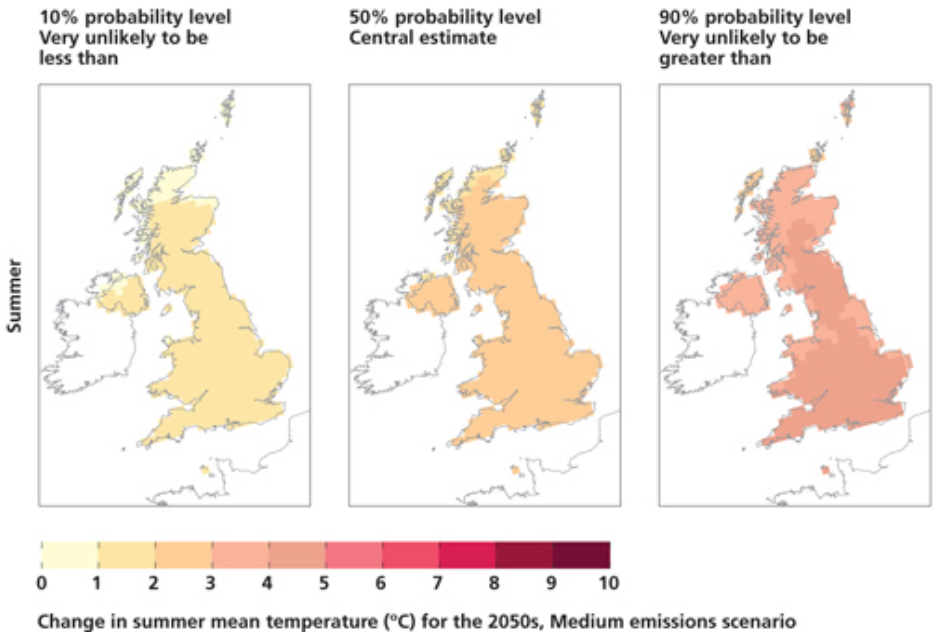


Fig 1 **Example UK climate projection map (source: TSB)**

The predictions can also be broken down into plume plots for different regions. Figure 2, from the Technology Strategy Board's report *Design for Future Climate*,[3] shows the annual mean temperature change in south east England for all emissions scenarios. The central dotted line shows the central estimate.

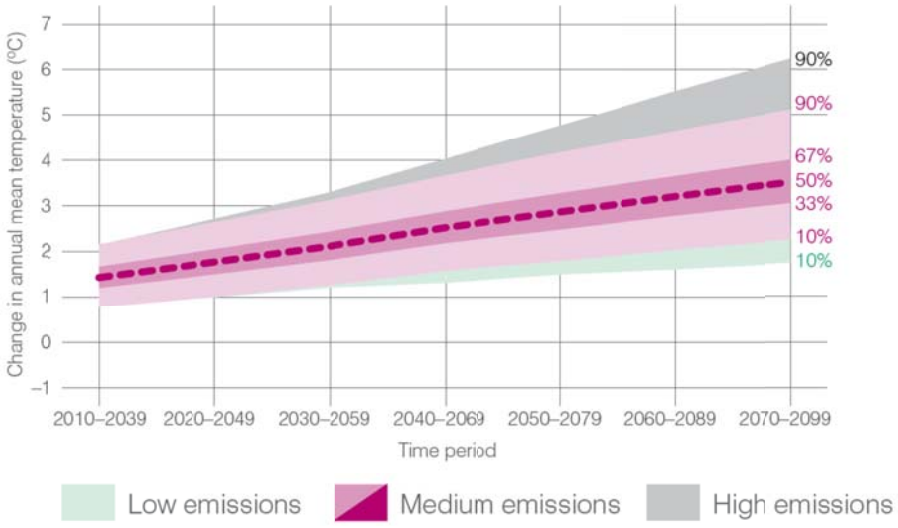


Fig 2 **Annual mean temperature change in south east England for all emissions scenarios (source: TSB)**

Data of this type, showing probabilities for different emission scenarios, allows building owners, planners and designers to make informed decisions based on a risk-analysis approach. Global warming will influence the design and operation of buildings in this decade and beyond – to reduce emissions (mitigation) and to cope with changes to the climate (adaptation).

CAN WE ADAPT?

In an article for The Washington Post on 17 November 2010 Bjorn Lomborg wrote:[4]

'The process is called adaptation, and it's something we humans are very good at. That isn't surprising, since we've been doing it for millennia. As climate economist Richard Tol notes, our ability to adapt to widely varying climates explains how people live happily at both the equator and the poles. In the debate over global warming, in which some have argued that civilization as we know it is at stake, this is an important point. Humankind is not completely at the mercy of nature. To the contrary, when it comes to dealing with the impact of climate change, we've compiled a pretty impressive track record. While this doesn't mean we can afford to ignore climate change, it provides a powerful reason not to panic about it either.'

He then concludes: *'Obviously, ..., adaptation is not a long-term solution to global warming. Rather, it will enable us to get by while we figure out the best way to address the root causes of man-made climate change.'*

3. OVERHEATING OF UK HOUSING

The Economics of Climate Resilience (ECR) project by DEFRA developed an economic framework to assess the case for adaptation in the UK.[5] This project assessed the extent to which individuals and organisations are likely to adapt to climate change effectively and whether further action by government, other organisations, or individuals is needed.

One of the themes was overheating in residential housing. Overheating is not generally perceived to be a risk among UK householders and air conditioning in houses is not common. Analysis of two case study areas in London and the West Midlands suggests that, at current rates of uptake, 1% of households would have air conditioning by 2050 (compared to 0.6% in 2010) and that the energy demand for cooling could triple between 2010 and 2050 in both areas. If half of households were to install air conditioning systems by 2050, energy demand for cooling could be 37 times greater in 2050.

The report noted that the ability of individuals and organisations in the housing sector to prepare for the effects of overheating – referred to as 'adaptive capacity' – is generally low. Potential adaptation actions for cooling in buildings were suggested including:

- Active cooling (e.g. use of air conditioning systems).
- Passive design measures (e.g. increased thermal mass in new builds, insulation, improving ventilation, and reducing solar gain by shading or reflective surfaces).
- Behavioural responses (e.g. changing clothes, avoiding putting vulnerable people in dwellings particularly susceptible to overheating, and changing cultural norms such as comfort temperature).
- External cooling with green infrastructure (e.g. planting trees).

Figure 3 shows that the majority of these adaptations, while effective, are not currently widespread.

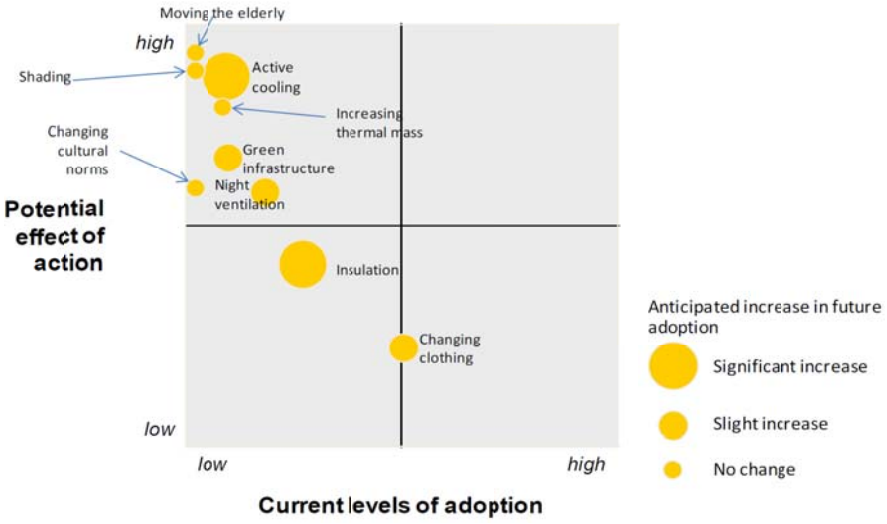


Fig 3 **Potential adaptation measures and their effectiveness in UK housing (source: DEFRA)**

4. FURTHER INFORMATION AND RESEARCH

The subject of climate adaptation is gathering momentum, and a lot of research has been undertaken in the last few years to try to understand its impact socially, environmentally and economically.

Global context

The fifth version of the IPCC Assessment Report (AR5) will be finalised in 2014.[6] It will put a greater emphasis on the socio-economic aspects of climate change and the implications for sustainable development, risk management and the framing of a response through both adaptation and mitigation.

UK buildings

Between 2010 and 2012 the UK Technology Strategy Board's Design for Future Climate competition funded 50 new build and refurbishment projects to investigate and develop adaptation strategies during the design and construction stages.[7]

The book *Design for Climate Change* by William Gething and Katie Puckett, draws on the lessons from the first 26 projects to provide practical advice to building designers on how to deal with the impacts of climate change on the built environment under three broad categories:

- Comfort and energy performance – warmer winters may reduce the need for heating, but it will be difficult to keep cool in summer without increasing energy use and carbon emissions.
- Construction – resistance to extreme conditions, detailing and the behaviour of materials.
- Managing water – both too much (flooding) and too little (water shortages and soil movement).

Notes

All websites were accessed on 15 June 2013 unless noted otherwise.

1. http://ec.europa.eu/clima/policies/adaptation/faq_en.htm

2. Jenkins, G. J., Murphy, J. M., Sexton, D. M. H., Lowe, J. A., Jones, P. and Kilsby, C. G. (2009). UK *Climate Projections: Briefing report*. Met Office Hadley Centre, Exeter, UK. http://ukclimateprojections.defra.gov.uk/

3. *Design for Future Climate: opportunities for adaptation in the built environment* – a report by Bill Gething for the UK's Technology Strategy Board. Published in 2010.

4. www.washingtonpost.com/wp-dyn/content/article/2010/11/16/AR2010111604973.html

5. *FRP - Final Report : CA0401 - Buildings and Infrastructure Theme: Overheating in Residential Housing*, prepared for DEFRA, Feb 2013. http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=18016

6. www.ipcc.ch/index.htm

7. https://connect.innovateuk.org/web/design-for-future-climate