



UKCP18 briefing report

The implications of climate change on civil engineering practice

Introduction

In November 2018 the UK Meteorological Office released the UK Climate Projections 2018 (UKCP18). These use cutting-edge climate science to provide updated observations and climate change projections out to 2100 in the UK and globally.

Projections are made covering a broad range of aspects of climate change integral to the role of Civil Engineers, including future precipitation, temperature and sea level rise, all impacting on aspects such as flooding, drainage or building design, transportation, water supply, energy or coastal management and the natural environment, reinforcing the need to view such issues in a comprehensive manner, working with communities and other professionals in facing up to unprecedented change.

UKCP18 prompts a new way of thinking, building upon and updating the UK Climate Projections 2009 (UKCP09), which have been widely used in civil engineering design over the last decade. This ICE note summarises the key features of UKCP2018 and highlights its importance for future civil engineering practice.

Understanding UKCP18

The UKCP18 projections are based around scenarios for future greenhouse gases referred to as representative concentration pathways (RCPs). These scenarios, updated from those used in UKCP09, cover a range of assumptions around future population, economic development, and explicitly including the possibility of mitigation of greenhouse gas emissions.

Each pathway drives a different range of simulated global mean temperature increases over the 21st century. The RCP pathways lead to a broad range of climate outcomes

but are neither forecasts nor policy recommendations. The scientific community cannot reliably place probabilities on alternative scenarios, and so cannot say which scenario of greenhouse gas emission is most likely. *Even so, the pathways provide a strong framework for considering design and planning into the future.*

It is important to understand that UKCP18 **does not capture all possible future outcomes**. The probabilistic projections aim to provide the primary tool for assessments of the ranges of uncertainties in UKCP18. However, they may not capture all possible future outcomes. The probabilities need to be interpreted as being an indication of how much the evidence from models and observations, taken together, support a particular future climate outcome - **the probabilities are conditioned on methodological choices and expert judgement**. *Users of UKCP18 are urged to consider the critical decision framework for their particular problem, assessing the consequences of different climate change outcomes in terms of particular actions, decisions and acceptable levels of risk.*

UKCP18 uses downscaling – the process of generating model data at higher spatial and/or temporal resolution – this **adds detail but also increases the level of uncertainty**. **Substantial additional sea level rise cannot be ruled out** – such as the UKCP09 H++ scenarios which are an estimate of the low probability, high impact range for sea level rise around the UK to 2100 (see Lowe et al, 2009). The balance of changes in temperature and rainfall may have significant impacts on evaporative demands, runoff and groundwater recharge so **important impacts for natural vegetation, agriculture, water resources and the environment cannot be ruled out**.

Both the model projections and probability distribution for a given outcome are likely to evolve in the future. **This is not a reason for delaying carrying out a risk assessment** but may impact on the actions taken to build resilience.

Equivalence with UKCP09.

UKCP18 has many improvements over UKCP09 and provides some additional tools. The previous projections for UKCP09 made use of the SRES B1 ("Low"), SRES A1B ("Medium") and SRES A1FI ("High") scenarios, reported on in the IPCC's 4th assessment report. UKCP18 now provides improved probabilistic projections for five scenarios, including SRES A1B, which allows an inter-comparison of UKCP09 and UKCP18 results. UKCP18 introduces four new emission scenarios: RCP2.6, RCP4.5, RCP6.0 and RCP8.5, used in the Intergovernmental Panel on Climate Change's latest 5th assessment report, which span a greater range of future CO2 concentrations and associated climate forcings than the SRES scenarios used in UKCP09.

UKCP18 RCP	Increase in GMS temperature (deg C) by 2081 - 2100	UKCP09 most similar SRES scenario (in terms of temperature)
RCP2.6	1.6 (0.9 – 2.3)	None
RCP4.5	2.4 (1.7 – 3.2)	Low emissions (SRES B1)
RCP6.0	2.8 (2.0 – 3.7)	Between low and medium (SRES B2)
RCP8.5	4.3 (3.2 – 5.4)	High emissions (SRES A1F1)

These changes have resulted in UKCP18 being produced and UKCP18 having some differences to UKCP09, although the large overlap of projected ranges between UKCP09 and UKCP18 is evident for many climate metrics.

It should be noted that UKCP18 uses a different baseline period (1981 - 2000) compared to UKCP09 (1961 – 1990).

Planning Perspective

UKCP18 builds on the approach established throughout UKCP09, rather than radically altering the outcome projections. Further work is in progress and further aspects of climate change will emerge and be reported upon. Similarly, current projections will be refined over the coming years. This is an on-going process. However, this is not a reason for delaying making decisions, nor for assuming that changes will not extend beyond the conventional planning horizons; for water resources 25-years has been the standard planning period, but many water utilities are looking at longer time periods.

One important element of work within UKCP18, reinforcing this principle over even longer planning periods, has been to look beyond 2100. As an example, in terms of sea level rise (SLR) up to around 2m by 2100 (UKCP09 H++ scenario) can still be considered a useful plausible but unlikely high-end sea level pathway for decision-making.

Looking beyond this timescale there is now a large body of literature that suggests that increasing sea level will likely continue beyond 2100 for a considerable period of time, even if global greenhouse gas emissions are restricted.

Exploratory time-mean sea level projections to 2300 replicate this established view, under all RCP climate change scenarios. Under RCP8.5, for London and Cardiff the projected range at 2300 might be between 1.4m and 4.3m (lower for Edinburgh and Belfast at 0.7m to 3.6m). The projections are considered to have far greater uncertainties than projections for the 21st century.

However, "As a horizon-scanning exercise the results may be useful to motivate stakeholders to think beyond 2100 and provide an approximate set of sea level change values against which vulnerabilities might be compared." (UKCP18 Marine report)

For many users, it may be more important to consider climate change at the mid-21st century but, critically, this will depend on the issues being assessed. Potentially, in terms of direct private investment, this may be over a shorter term timeframe. However, for investment, strategy and policy decisions, influencing societal planning, there may need to be consideration of the longer term consequences of choices made in the present epoch. In the near-future (a few years and possibly up to a decade or more), typically, predictions and projections are dominated by natural variations in weather and climate when measured relative to a recent baseline period of 1981-2000. However, as we look further into the future a large body of research has found that the trends of a changing climate become more obvious and pronounced.

In UKCP18, the projections over land show a trend towards warmer temperatures throughout the century, with more warming in the summer. The marine projections show a continuation and likely acceleration of the sea level rise observed around the UK, and even if emissions are significantly reduced this century, the sea level rise will continue well beyond year 2100.

Issues

Headline messages:

- UKCP18 does not contradict the core themes and messages from UKCP09, rather it builds on them.
- In UKCP18 the magnitude of the drivers for the planned adaptation of UK infrastructure to meet the challenges of climate change are now more pressing than at the time of UKCP09.
- The range of outputs is more diverse and therefore allows users more scope to undertake more robustly grounded risk-based analysis and hence informed decision making.
- The inter-relationships between all infrastructure sectors mean that a coordinated interdisciplinary systems perspective - involving engineering (all disciplines, not just Civil), environmental science, economics and social sciences - is now even more important.
- This requires a rethinking of engineering education content and training both at University and in the professional development of Chartered professionals.

Technical outputs:

- UKCP18 provides output data at enhanced spatial and temporal resolutions compared to UKCP09;
- The efficient use, interpretation and analysis of these data would be improved by active practitioner user groups to avoid (wherever possible) duplication of effort and to promote consistency of interpretation;
- These are still relatively early days for technical glitches in data downloads and use of the data;
- There is a need to encourage the rapid development and roll-out of UKCP18 tools for the different practitioner user sectors.

Theme areas:

Water resources:

- As for UKCP09, the hydrometric outputs from UKCP18 will allow modelling of surface water flows for a range of different climate futures. The improvement for UKCP18 would appear to be (amongst other things) better spatial resolution of variables, year on year estimates up to the end of the planning horizon, and better consistency between variables;
- There are national Research Council Funded programmes (e.g Droughts and Water Scarcity - <https://nerc.ukri.org/research/funded/programmes/droughts/>) which should be

considering the possible implications arising from UKCP18 on future water resource planning.

- EA has recently initiated a new water resources initiative in the form of a National Framework to support a National Policy Framework. It would seem reasonable to presume that EA will take a lead on the interpretation of UKCP18 for future water resource (not just Public Water Supply) planning.
- ICE should look to support and endorse the development and roll-out of initiatives led by EA and the practical uptake of R&D programmes such as Droughts & Water Scarcity.

Fluvial flooding:

- Further UKCP18 results will become available in Summer 2019 – these will provide more detail of localised heavy rainfall for flood risk assessments
- EA is expected to update over the next 6 months its Flood and Coastal Erosion Risk Management (FCERM) strategy, its climate change allowances for development planning, and new allowances for peak river flows
- Flood Risk Management Plans (FRMP) – 2nd cycle FRMPs are due to be developed over 2019-2020; EA is expected to produce guidance

Coastal Management

- UKCP18 reinforces the messages from UKCP09 that the FCERM problem moves beyond that of just adding another brick on the wall, to rethink our approach to one within a broader concept of coastal management and adaptation.
- This potentially moves decision making into a different unprecedented playing field where, while it is important to align thinking with existing legislative structures and procedure, thought should be given to how these structures need to evolve.
- In many areas, the priority will need to include thought about the timeframe of the decision-making process, rather than just the immediacy of dealing with current risk.
- Such a thought process must be developed with the public and affected stakeholders, who will be needed to help explain future risks and necessary mitigative actions.
- This all requires thought about how we redefine problems, rethinking our approach and defining what we should be doing regarding coastal management and adaptation.

ICE call to action

ICE and its members shape society and have a responsibility to take account of climate change within that process. In doing so it shall

- Ensure that ICE members, groups and stakeholders are aware of UKCP18 and is considering its implications in respect of their own professional interests (implications are wide ranging e.g. geotechnical implications of drier summers).
- Run initiatives to increase general awareness in the membership (evening meeting, NCE article).
- Revisit past publications on climate change to ensure that they remain relevant (taking account of such issues as the Paris Agreement and with increased emphasis on adaptation) as a precursor to more detailed assessment of how climate change will reshape the world.