Ireland at Risk

CRITICAL INFRASTRUCTURE

ADAPTATION FOR **CLIMATE CHANGE**

THE IRISH ACADEMY OF ENGINEERING

An ounce of prevention is worth a pound of cure.

Cover image:

Flooding at Mallow, Co Cork, in 2009. We can expect to see more flooding like this, unless adaptation measures are implemented. Image courtesy OPW.

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No.2

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Supported by:

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This report is based on presentations and discussions at a symposium, involving experts from across the island of Ireland, convened by the Irish Academy of Engineering in Dublin in April 2009.

It is now widely recognised that Ireland must adapt to the impacts of climate change. The engineering profession will play a central role in identifying the climate change challenges facing us across the island, and in proposing and implementing appropriate and cost-effective adaptation measures. This report focuses on the key adaptation strategies needed for critical infrastructure, specifically: energy supply, water services and flood alleviation. Our aim is to ensure that the engineering profession contributes fully in formulating policy and in planning for the potentially dramatic developments expected over the coming century.

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We are grateful to the institutions and individuals who provided illustrations for this report, in particular: the British Geological Survey, Dublin City Council, the Environment Agency UK, Arup Consulting Engineers Cork, OPW, Scott Wilson Consulting Engineers, and Dr Peter Coxon TCD.

The views expressed here are those arising from the workshop, and do not necessarily reflect the views of the various bodies that supported the project

This report, and the full text of the keynote papers presented at the Dublin workshop, are available online at www.iae.ie.

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Appendix 1:

Keynote Abstracts

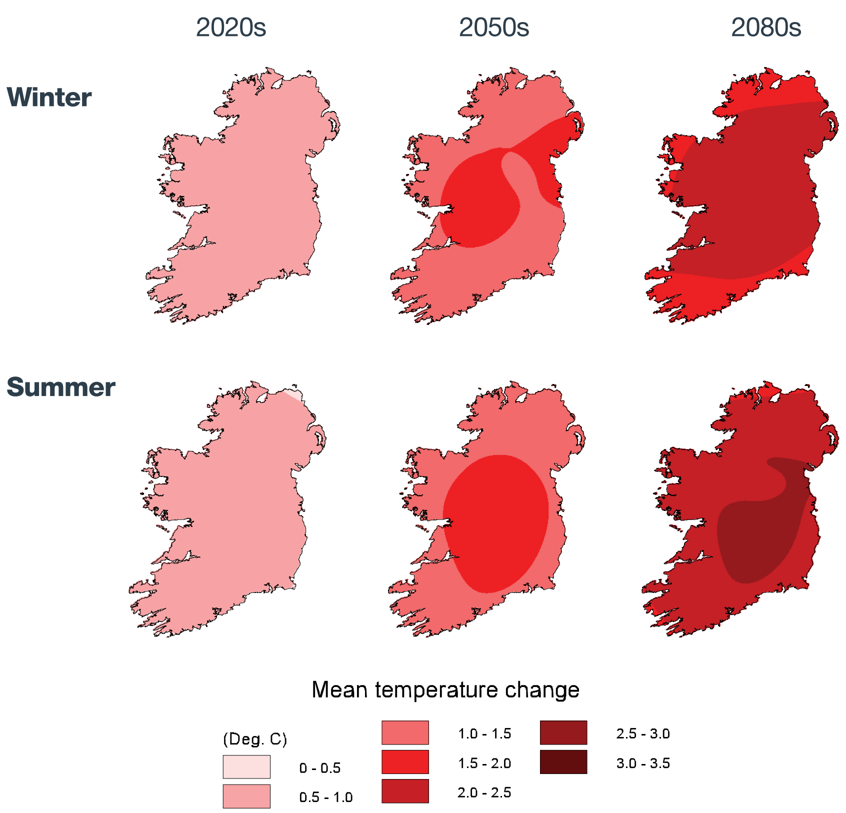
The full text of the four keynote papers is available on the Irish Academy of Engineering website: www.iae.ie.

1: Climate change: meeting the challenge of adaptation

Conor Murphy & Rowan Fealy, Irish Climate Analysis and Research Units (ICARUS), Dept. of Geography, NUI Maynooth

Work on climate change in Ireland to date has been successful in refining the likely impacts over the coming century. However, significant uncertainty and challenges remain and researchers in this critical area must work closely with end-users of data to ensure the best possible information is used for decision making and designing for the future. While acknowledging that some uncertainty remains, the following is a summary of likely changes in the key climate parameters.

- Temperatures are likely to rise everywhere relative to the present, with greatest increases suggested for summer and autumn of up to 3.4ºC by the end of the century.
- With warmer average temperatures, we can expect a change in extreme events, with more intense and longer heatwaves likely, and less frost.
- Precipitation remains an uncertain variable, with different modelling approaches predicting differences in the extent and spatial distribution of changes. We do see, however, a robust signal of greater seasonality, with wetter winters and drier summers likely. No clear trend is evident yet for spring and autumn.
- As changes in average climate progress, changes in extremes can be expected, with the magnitudes likely to increase and extreme events for all climate variables (with the exception of minimum temperatures) likely to become more frequent.
- Increases of 8-11% in 60m-height average wind speeds are likely in winter by mid-century, and decreases of 14-16% in summer, but assessment of this variable to date has been subject to high levels of uncertainty.
- In relation to stream flow, we expect significant increases in winter and spring flows, in the order of 20% in winter by mid- to late-century. Reductions of over 40% are likely in summer and autumn in many catchments. Individual catchments show different signatures of change, however, depending on characteristics determining runoff response.
- Flood events are likely to become more frequent, with the current '50-year event' likely to become a '10-year event' by mid- to late-century. While uncertainty remains, low flow events are also likely to become more frequent.
- IPCC scenarios suggest a likely sea level rise of between 0.28 to 0.43m by the end of the century, relative to 1980-'99. However, recent thinking suggests that this may be too conservative, and increases of over 1m have been suggested. Localised rises will also depend on local characteristics, such as isostatic rebound of the land and topography.



Ireland will be warmer: average temperatures are likely to increase everywhere in the coming decades. Source: ICARUS, NUI Maynooth, 2007.

Increased storminess, higher sea levels and stronger wind speeds will all contribute to higher waves and storm surges. Combined with riverine flooding, these will pose serious flood risks in many of our coastal cities and for key infrastructure.

Even if greenhouse gas emissions were capped at 2000 levels some degree of climate change can be expected due to inertia in the climate system. In light of these findings there is a requirement to urgently review the security of critical infrastructure; to prioritise adaptation measures for existing infrastructure; and to incorporate adaptation provisions in all new infrastructure. Failure to do so would place unacceptable risk on the wellbeing of society.

2: Critical Infrastructure – water supply

Michael Phillips, Dublin City Engineer, Dublin City Council

In Ireland, we still take water for granted, but not for long. As climate change takes effect, there will be increasing disparity between the places where water availability is greatest (the west and north-west), and where it is most needed (east and southeast).

By 2026, Ireland's population could hit 7.8 million. More people, demanding more water, together with more irrigation, mean supply would have to double (assuming adequate sources are available), and prioritisation will become an issue. Ireland will remain relatively 'water rich', but to ensure a sustainable supply we will need to reduce demand, through long-term planning and pricing policies, conservation, harvesting and even re-using non-potable water.

The implementation of the EU Water Framework Directive, the Flood Directive and the creation of River Basin Management Plans have resulted in

Climate change will affect drinking water quality both directly and indirectly.

an integrated approach to managing the quality of the river catchments. This approach will greatly assist in defining acceptable limits and reducing threats to the catchments.

Currently, 70% of our water comes from surface freshwater, and about 30% from groundwater. The key part of any supply is the quantity and quality of the source. Water quality in Irish rivers has improved in recent years, but increasing pressure on sources heightens the risk of pollution, and we will need bank-side storage reservoirs to allow pollution 'incidents' to pass inlet pipes and ensure clean raw water.

The issues for adaptation are: Where will the significant water resources be located? How can the resources be quantified and protected sustainably? How can we effectively educate users about demand and re-use? How can we prepare a strategy to reduce uncertainty?

In a resilient system, every town or city would be able to draw on more than one source, but the Irish networks are not interconnected (for example, Dublin is not connected to Waterford). In Dublin, supply and demand is already finely balanced, and with reservoirs holding at most three day's supply, the region needs additional storage capacity.

Ireland is small, so building new pipelines to ensure continuity of supply is not technically difficult, but it would be costly: Dublin is currently investing €10 million to replace 10km of pipeline, but with 800km of watermains over 80 years old, significant investment is needed.

Adequate energy is critical in ensuring the delivery of potable water. Some treatment plants have generating units (e.g. hydro), but most rely on the national grid to power their pumps, although Dublin city is fortunate in that 80% of its water falls by gravity from treatment works in Kildare and Wicklow. Modern water treatment is sophisticated and, to maintain supply, it is also essential that staff have the relevant training. The following are some of the other factors that will affect water infrastructure:

- Pipelines will be more prone to cracking, due to greater soil movement from wetting and drying cycles
- Assets on flood plains and coasts will be at increased risk from flooding, storm damage, coastal erosion and rising sea level
- Existing sewerage was not designed for the more intense rainfall expected
- Dams will be more prone to siltation, resulting from increased soil erosion, or overtopping due to storms.

Currently, it can take 10 years to implement decisions about infrastructure in Ireland. Given the uncertainty about future climate change, how can we plan for a 20- or even 40-year time horizon? The challenge is to develop a better understanding of the known hazards, and the changing and newly emerging vulnerabilities, particularly in relation to identifying critical infrastructure so as to ensure that the basic services can be maintained to the public in times of adversity.

3: Flood Protection Infrastructure

Tony Smyth, Director of Engineering Services, Office of Public Works (OPW), Dublin

Flood defences that protect critical infrastructure from flood damage can themselves be considered as critical infrastructure. They include recently built defences; older structures (e.g. Land Commission embankments), which may provide some flood protection but are not always identified as such, and whose design and condition may be uncertain; and urban drainage networks, much of which may date from Victorian times.

Traditionally, the design of flood defences was based on historic data, but climate change means design must now take account of future predictions for rainfall, river flows and sea levels. The OPW, which runs a sizeable flood defence programme, already 'climate checks' its designs against two scenarios of climate change, including a possible average sea level rise of one metre. While the standards for newly designed flood defences take climate change into consideration, these allowances are based on current science, and must be reviewed and updated as further research is undertaken.

Drainage networks designed and built in the past may not be able to cope with the more frequent and intense rainfall we expect in future.

In the Republic of Ireland, the OPW has begun a catchment flood risk assessment and management (CFRAM) programme to develop and implement an integrated, pro-active and catchment-based approach, to ensure effective management of existing and potential future flood risks. Pilot studies are underway on four catchments, as a prelude to a national programme, and climate change is considered at every stage.

The CFRAM programme will generate both a flood asset database (recording and identifying major flood defences, and informing the relevant owner), and flood extent maps, showing areas at risk from flooding. The OPW, with the Dept. of Environment, Heritage and Local Government published draft guidelines on 'The Planning System and Flood Risk Management' in 2008.

The approach in Northern Ireland is similar, where the Rivers Agency has already developed asset management plans for its flood defences, and produced a strategic flood map. The Department of Environment (NI) Planning Policy Statement 15 (PPS 15) deals with planning and flood risk for Northern Ireland.

The biggest challenge is the uncertainty associated with climate change. If we knew with confidence what was going to happen, it would be easier to take decisions. Flood defences must be designed to withstand extreme events, but climate models have difficulty predicting extremes. This uncertainty means that we have to implement policies based on emerging data and assumptions. To address this uncertainty, the OPW has identified three areas requiring urgent research:

- Rainfall and climate
- Catchment response
- Sea level and storm surges.

Providing adequate and resilient flood protection to our towns and cities is expensive. This research will help reduce uncertainties, and allow engineers to design, build and maintain the most cost-effective flood defences.

4: Energy Infrastructure: adaptation for climate change

Michael Mackey (Head of Engineering), & Tom Bree (Manager, Environmental Engineering), ESBI Engineering

Every day, we hear of new initiatives in the energy sector to mitigate climate change. While major changes are underway in energy infrastructure, little attention has been given to climate *adaptation*.

Ireland's location in the Atlantic Ocean off Northern Europe has major implications for our energy supply. We are heavily dependent on importing fossil fuels over long distances, yet we have a favourable setting for renewable generation from wind and ocean power. The Northern Atlantic is linked to the Arctic Ocean, however, where climate and conditions are changing fast. Future energy infrastructure development must therefore address two distinct issues:

- The exploitation of renewable energy resources
- Withstanding the environmental impacts of climate change.

In the energy sector, the lead-time from planning to operation can be 10 to 30 years. Although this has speeded up significantly in recent years, thanks to technological advances, projections for energy supply and demand must still look forward 20 to 40 years, and take account of socio-economic factors and climate change. In the context of energy supply, the latter can include flooding of gas network marshalling stations and electricity substations, or the destruction of electricity lines by high winds. Hence the energy sector must address a wide range of adaptation issues, including:

Dublin City Council

An eastern by-pass option for Dublin: the proposed transport embankment would also protect the vulnerable Ringsend and Sandymount areas against the floods, storms surges and rising sea levels.

- Socio-economic models and methodologies for integrating adaptation in predicting future electricity demand
- Prepare wind and wave resource atlases for future scenarios
- Collect information on the climate parameters that will affect the efficiency and capacity factors of energy conversion and storage systems
- Incorporate adaptation in the Codes and Standards for design of power plants, electricity and gas network substations, oil storage and dam safety, based on predictions of extreme rainfall, wind, wave and surges. These will be higher than in most current design situations
- Analyse the so-called 'water-energy nexus' taking account of changes in rainfall, evaporation, river flows, sea level and storm surges
- Coastal protection measures at oil storage installations, pipelines, power generating stations, network substations and seabed cables
- Bioenergy action plan measures, accounting for seasonal changes in crop temperature and water cycle.

Measures to address adaptation must be comprehensive and integrated with other sectors, taking account of multiple factors through national and international policies.

Appendix 4:

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Appendix 5:

Acronyms

C4I	Community Climate Change Consortium For Ireland
CCCma	Canadian Centre for Climate Modelling and Analysis
CFRAM	Catchment Flood Risk Assessment and Management
CSIRO	Commonwealth Scientific and Research Organisation, Australia
DRD	Department of Regional Development
ECHAM	European Centre Hamburg Model
EPA	Environmental Protection Agency
GCM	Global Climate Model
HadCM	Hadley Centre Coupled Model
IAE	Irish Academy of Engineering
ICARUS	Irish Climate Analysis and Research Units
IPCC	Intergovernmental Panel on Climate Change
NI	Northern Ireland
OPW	Office of Public Works
RCM	Regional Climate Model
RoI	Republic of Ireland
SNIFFER	Scotland and Northern Ireland Forum for Environmental Research
SRES	Special Report on Emissions Scenarios
UKCIP	United Kingdom Climate Impacts Programme

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- Ireland at Risk - No. 1: The Impact of Climate Change on the Water Environment
- Engineering a Knowledge Island
- Ireland's Energy Policy
- A Vision of Transport in 2050
- Ireland's Environment
- The Government's Technology Investment Fund
- Infrastructural Spatial Development for the Island of Ireland
- Creating Europe's Most Attractive Environment for Intellectual Property

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