Climate change impacts and recommended adaptive actions in the construction industry in Ireland

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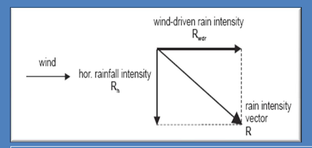
Introduction

The construction industry in Ireland is a vast area and its economic importance to Ireland is substantial. As such, the impact of weather and climate on the built environment has been well documented and the principal agents identified: water; ice; wind; salts; thermal changes; atmospheric pollution; and microbiological organisms.

In adaptation terms, solutions to Irish issues may already exist in other countries. Nonetheless, an assessment of anticipated climate change impacts on key vulnerable areas of the construction industry is lacking in the Irish context. Two key areas have been identified that could have significant impacts on construction in Ireland: wind-driven rain; and effluent management.

Wind-driven rain (WDR) is rain that is given a horizontal velocity component by the wind causing it to fall obliquely onto the building envelope.



WDR intensity Rwdr and horizontal rainfall intensity Rh (Blocken and Carmeliet, 2004)

It is a particular problem in the north and west of Ireland, two of the windiest regions of Europe. Increases in WDR can lead to building envelope penetration and moisture ingress, with consequent negative implications for U-values, occupants' health and maintenance requirements.

Effluent management, specifically septic tanks, is an issue that is particularly relevant to Ireland. Unlike many more urbanised European countries nearly 40% of the population live in rural areas. This has led to the existence of over 400,000 septic tanks (CSO, 2010). With modelled increases in DJF precipitation, septic tank operation may be compromised by rising winter water tables, leading to groundwater contamination and breaches of the Water Framework Directive.

Wind-driven rain

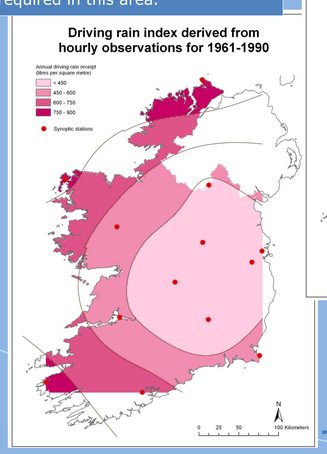
Wind-driven rain (WDR) is one of the most important climatological factors to affect the hygrothermal performance and durability of building envelopes (Karagiozis, A. *et al.* 1997). Models suggest that there will be upward autumn and winter trends in precipitation and wind speed, resulting in increased incidences of WDR. To aid mitigation and adaptation in such changed environmental conditions, new driving rain indices are calculated for current and future scenarios.

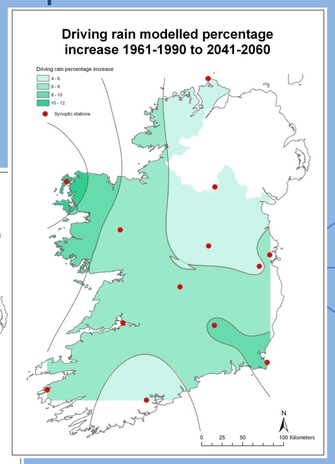
Methodology

A driving rain index for Ireland for current and future conditions is calculated using Irish Standard ISO 15927-3:2009 'Hygrothermal performance of buildings – calculation and presentation of climatic data – part 3: Calculation of a driving rain index for vertical surfaces from hourly wind and rain data' (NSAI, 2009). 1961-1990 hourly wind and rainfall data from 13 synoptic stations is supplied by Met Éireann, while modelled output is generated using HIRLAM to dynamically downscale HadCM3 data.

Key results

Percentage increases are most significant in the west of the country. In addition, an increase is noted in the south east, although due to the preliminary nature of results thus far further investigation is required in this area.





Septic tanks

Conditions for the siting of septic tanks in Ireland vary from 'slightly to seriously inadequate' over an estimated 40% of the country. Septic tanks are considered to be one of the principal sources of groundwater contamination (Daly *et al.*, 1993). For effective construction mitigation and adaptation strategies to be formulated in the face of potential rises in winter water tables, zones of vulnerability require identification.

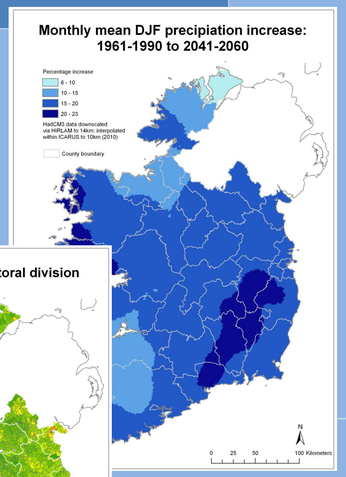
Methodology

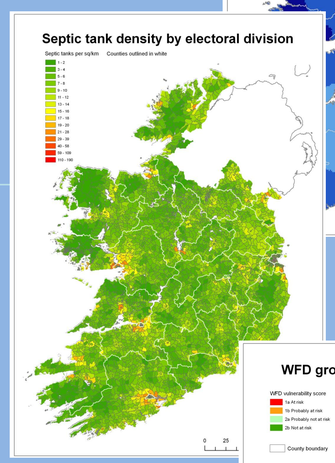
ArcGIS 9.2 is used to calculate and map septic tank density (STD) by Electoral Division. The nominal STD threshold to indicate potential vulnerability is 17 per square kilometre, based on the US EPA designation that any greater density than 16 constitutes a 'region of potential contamination' (US EPA, 1977; cited in Yates, 1985). Precipitation percentage increases for the period 1961-1990 to 2041-2060 are obtained by dynamically downscaling HadCM3 data via HIRLAM. Susceptible areas are identified by layering the datasets over WFD groundwater vulnerability maps in GIS.

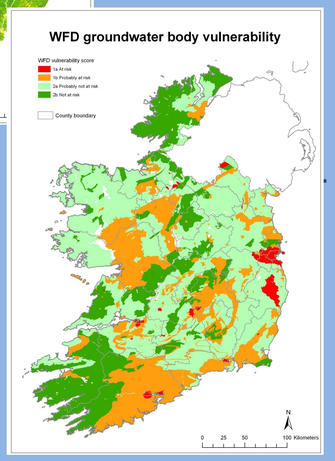
Key results

It can be seen that the more extreme DJF rainfall increases are anticipated in the west, south-west and south-east.

The primary areas of potential vulnerability are the suburban peripheries, where significant septic tank densities, increased precipitation, a general lack of mains sewerage and the likelihood of further development exist.







Conclusions

In the context of impacts on construction due to climate change, it can be seen that the apparently disparate areas of WDR and septic tanks elicit a common theme: that of the necessity to implement construction-related mitigation and adaptation strategies imminently.

Increased incidences of WDR mean that codes and standards need to be adapted to ensure buildings are constructed to mitigate for harsher climatic conditions, particularly in autumn and winter. Septic tank upgrade and replacement programmes will be required to mitigate for rising winter water tables, while adaptation options include the construction of wastewater treatment plants and stricter planning conditions on the construction of one-off rural housing *vis*-à-*vis* clustered development.

In either case, it would appear that climate change will have a significant effect on construction. In the north and west, more severe wind and rain will define changes in materials and practice. In the rest of the country, precipitation increase leading to changed settlement policy will be the dominant theme.

Acknowledgements

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