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Climate Change, Flood Risk Prediction and Acute Gastrointestinal Infection in the Republic of Ireland, 2008-2017

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Environmentally associated infectious diseases, including those driven by extreme weather events, represent a critical challenge for public health as their source and transmission are frequently sporadic and associated mechanisms often not well understood. Over the past decade, the Republic of Ireland (ROI) has persistently reported the highest incidence of confirmed verotoxigenic E. coli (VTEC) and cryptosporidiosis infection in the European Union. Moreover, recent climate projections indicate that the incidence, severity and timing of extreme rainfall events and flooding will increase dramatically over the next century, with Ireland forecast to be the second most affected European country with respect to the mean proportion of the population residing in flood-prone areas by 2100. This study aimed to assess the association(s) between potential flood risk exposure and the spatial occurrence of confirmed VTEC and cryptosporidiosis infection in Ireland over a 10-year period (2008-2017).

In 2012, the Irish Office of Public Works (OPW) initiated the National Catchment Flood Risk Assessment and Management (CFRAM) Programme within the framework of the Flood Directive (2007/60/CE), with high-resolution flood maps produced for coastal and fluvial risks and three risk scenarios based on calculated return periods (low, medium and high probability). Small area identifiers (national census area centroids) were used to attach anonymised spatially referenced case data to CFRAM polygons using Geographical Information Systems (GIS) to produce an anonymised dataframe of confirmed infection events linked to geographically explicit flood risk attributes. Generalised linear modelling with binary link functions (infection presence/absence) were used to calculate probabilistic odds ratios (OR) between flood risk (presence/absence and scenarios) and confirmed human infection.

Preliminary results indicate a clear relationship between both infections and hydrological risk. Over one third of all infection cases were reported within areas exposed to flood risk (VTEC 948/2755 cases; cryptosporidiosis 1548/4509 cases). Census areas categorised by a high (10-year Return Period) fluvial flood risk probability exhibited significantly higher incidence rates for both VTEC (OR: 1.83, $P = 0.0003$) and cryptosporidiosis (OR: 1.80, $P = 0.0015$). Similarly, areas characterised by low (1000-year Return Period) coastal flood risk probability were over twice as likely to report ≥1 confirmed case of cryptosporidiosis during the study period (OR: 2.2, P= 0.003). Space-time scan statistics (temporally-specific spatial autocorrelation) indicate an unseasonal peak of cryptosporidiosis cases occurring during April 2016, a majority of which took place within or adjacent to high flood risk areas (56% of total cases), revealing a potential relationship with the exceptional flooding events experienced during winter 2015-2016 (November-January). Further work will seek to identify the individual/combined flood risk (CFRAM) elements most significantly associated with the incidence of infections.

Flood risk assessment mapping may represent an innovative approach to assessing the human health impacts of flood risk exposure and climate change. The outcomes of this study will contribute to predictive modelling of VTEC and cryptosporidiosis in Ireland, thus aiding surveillance and control of these diseases in the future, and the causative nature of regional hydrology and climate.