Met Éireann's Weather and Climate Research Programme

Call for Proposals

RESEARCH CALL 2024

Topic 2

Multi-Hazard Flood Forecasting

Additional Information

December 2024

1 Background

Flooding is a multi-faceted hazard influenced by various processes, including hydrology, meteorology, and oceanography. It is one of the most critical natural hazards in Ireland, and its impacts are expected to intensify due to the combined effects of climate change and increasingly frequent extreme weather events. Coastal flooding, driven by storm surges, high tides, and wave action, often coincides with or exacerbates riverine flooding caused by heavy rainfall and river overflow. Traditionally, coastal and fluvial floods have been analysed as separate phenomena, but these approaches overlook the potential for significant interactions between the two systems. In regions where these systems converge—such as estuaries—the overlap of flood mechanisms creates unique and complex vulnerabilities. These regions are at heightened risk of multi-hazard flooding, where interactions between riverine discharge, tides, and storm surges amplify flood impacts.

This topic seeks to address these challenges by developing an integrated multi-hazard forecasting model that capture the complex interactions between coastal and fluvial processes, such as how storm surges can hinder river discharge into the sea, leading to upstream flooding. Focusing on Ireland's key estuaries, this research aims to advance our understanding of the interplay between riverine, tidal, and storm surge processes, and to provide actionable insights to develop flood forecasting capabilities in this area. Such models can be used to improve early warning systems, inform infrastructure planning, and guide policy decisions on flood risk management.

2 Objectives and Expected Outcomes

This research will deliver the following key outcomes:

2.1 Review of Current and Best Practices

- Conduct a comprehensive review of existing fluvial-coastal modelling approaches.
- Categorise methodologies by their complexity, data requirements, computational efficiency, and applicability to operational settings.
- Identify the strengths and limitations of current methodologies, giving consideration to: (i) the constraints of observations available in Ireland, including data type, resolution, and sparsity, and (ii) the complexities of forecasting both coastal and fluvial flooding, particularly for a coastline as intricate as Ireland's.

2.2 Data Needs and Observation Networks

- Assess the data requirements necessary for robust fluvial-coastal modelling, including hydrological, meteorological, and oceanographic inputs.
- Identify gaps in the current observation networks (e.g. river discharge, coastal gauges, bathymetry, etc.) and propose solutions to enhance data availability and quality. This should consider the requirements necessary to future proof the continued development of fluvial-coastal models in an Irish context.

2.3 Development of Coupled Flood Models

- Create a test model that integrates coastal and fluvial flood systems to simulate compound flood events, accounting for the interactions between factors such as river discharge, tides, and storm surges.
- This should be a test model developed for (a minimum of) a single estuarine location on the Irish coastline which is vulnerable to this type of flooding. There is no stipulation on the type of model it should be (e.g. fully coupled, physically based, hydrodynamic, empirical, data-driven, machine-learning, off-the shelf, bespoke etc.), and the range of processes it incorporates. However, it should be kept in mind that the proposed model should have the capability to be run in an operational flood forecasting setting (e.g. efficient, sub-daily run time) and provide actionable information which addresses a gap in current forecasting capabilities.

2.4 Flood Scenario Simulations

- Evaluate the performance of the coupled model under a range of realistic and extreme flood scenarios. Simulate scenarios such as:
    1. Heavy rainfall coinciding with spring tides.
    2. Storm surges combined with high river flows during prolonged rainfall events.

2.5 Testing and Validation

- Test the developed model for the selected estuarine region.
- Use historical flood events and observational data to assess the accuracy and reliability of the model.

2.6 Operational Recommendations

- Provide recommendations for integrating coupled fluvial-coastal modelling into flood forecasting systems.
- Develop guidelines for operational deployment and identify critical success factors for sustained use.

2.7 Future-Proofing Data and Models

- Outline the observational and environmental data requirements for ongoing model refinement.
- Align recommendations with international best practices to ensure long-term relevance and adaptability.
- Propose a roadmap for incorporating emerging technologies, such as artificial intelligence, high-resolution climate projections, and adaptive mesh modeling.

3 Budget and Duration

Proposals are invited for research projects with a maximum duration of **24 months** and a maximum budget of **€400,000**.