# PhD Positions in Flood modelling for Endeavour Programme

We have openings for motivated students to undertake PhD research that will improve the flood resilience of New Zealand communities through developing innovative flood modelling techniques. Two 3-year positions are available and will be supported by the New Zealand Government via the Ministry for Business, Innovation and Employment (MBIE) through a NIWA-led five-year Endeavour Programme on reducing flood risk in Aotearoa/New Zealand. The PhDs will be co-hosted by the School of Earth and Environment and the Geospatial Research Institute at the University of Canterbury in Christchurch, New Zealand, in conjunction with NIWA. An annual scholarship of NZ$30,000 plus fees is available to successful applicants.

Both PhD projects will address aspects of flood modelling including issues surrounding climate change and will feed into and work with the wider group of Endeavour Programme researchers. The PhDs are to focus on the following research (see below for further details):

PhD 1: *Advancing methods of uncertainty estimation in flood inundation modelling using machine learning approaches*.

PhD 2: *Advancing methods of rapid flood risk scenario assessment using hybrid approaches of hydraulic modelling and machine learning*.

Computer literacy (e.g. Python, Matlab or similar), knowledge of hydraulic modelling and machine learning techniques are highly desirable. Numeracy and excellent written and oral communication skills are essential. The candidates should expect to interact with a multidisciplinary team of researchers throughout Aotearoa/New Zealand and internationally. The research results will have global applications to flood prone regions and will be published in national and international peer-reviewed journals.

Please direct all enquiries to the project co-supervisors Dr. Emily Lane (NIWA Taihoro Nukurangi, Emily.Lane@niwa.co.nz) and Prof. Matt Wilson (University of Canterbury, matthew.wilson@canterbury.ac.nz). Applications should be sent by email care of the GRI Manager, Dr. Melanie Tomintz (gri-enquiries@canterbury.ac.nz) no later than **31 January 2021**. Please submit the following documents as part of your application:

1. A full curriculum vitae, including details of any prior publications;
2. A cover letter outlining your motivation and suitability for the research project;
3. Contact details of at least two referees; and
4. A GPA report obtained from https://support.scholaro.com/portal/kb/articles/canterbury (those with New Zealand or United States qualifications are not required to use Scholaro).

In your correspondence and cover letter please indicate if you have a preferred PhD project.

## Research programme details

The PhD projects are part of the 5-year multi-stakeholder research programme *"Reducing flood inundation hazard and risk across Aotearoa/New Zealand"*, running from 2020 to 2025. Flooding is one of New Zealand's most damaging hazards. It is also the hazard that will change the most rapidly in intensity and nature as climate change impacts become realised. For instance, flash flooding caused by very heavy rainfall over a short period of time is expected to increase the most dramatically. At the same time our country is undergoing intense urban development that, if not linked to climate futures, will increase the risk to people's homes and wellbeing. These dual challenges make reducing flood risk extremely difficult for our current planning and response systems. There is a knowledge vacuum about the scale of these problems, the integration of different policy domains, and the details of how different parts of the country will be affected.

Our research programme will support the changes that are needed. We will produce New Zealand's first consistent national flood map, showing where flooding is likely to occur, but also identify how vulnerable our assets and taonga are. In partnership with local and central government agencies, iwi, communities and key financial organisations we will work collaboratively to design, test and establish novel decision-making practices that integrate different climate and socio-economic projections and promote proactive adaptation to changing flood risks.

Recent flooding events have demonstrated the ongoing impacts of flooding are not restricted to rescuing those inundated by water but are felt widely through society and the economy. We will work closely with communities to understand these cascading impacts and how we can be better prepared for them. This programme will generate information and guidance that is immediately relevant as local and central government form the regulations and policy that will drive our response to climate change.

## PhD project details

### PhD 1: Advancing methods of uncertainty estimation in flood inundation modelling using machine learning approaches.

Flood risk assessments require significant volumes of geospatial and other data, which each have multiple associated errors which are propagated through the modelling system to varying and often unknown degrees. Initially, this PhD project will characterise this uncertainty in detail for selected study sites, using automated data processing techniques for the creation of flood modelling inputs from source data, which provide different representations of model grids that each account for the statistical properties and spatial correlations of errors and uncertainties in source data. These representations will then be used to determine the variability in model outputs using a Monte Carlo framework and high-throughput computing, enabling us to trace uncertainties through the model system and identify critical contributions towards this uncertainty. Based on this information, the PhD project then aims to utilise machine learning approaches to develop a generalised uncertainty estimation method which may enable the optimisation of model inputs and the rapid estimation of the reliability of flood risk estimates.

### PhD 2: Advancing methods of rapid flood risk scenario assessment using hybrid approaches of hydraulic modelling and machine learning.

The PhD project will be specifically focussing on a case study working with the Wairewa Rūnanga based near Little River, Canterbury, New Zealand. Current computing power means flood risk assessments are usually limited to a handful of scenarios for each catchment of interest. This PhD project will investigate the feasibility of using a hybrid hydrodynamic/ machine learning model to reduce the numerical modelling load and enable probabilistic modelling. The project will construct a population of large and extreme events based on multiple variables (rainfall duration and intensity, river flow, lake water level, etc) to understand what can lead to inundation and the relationship between drivers of inundation and events in Wairewa's written and oral history. Selected scenarios will be modelled and the results of these will be used to train a machine learning algorithm to produce inundation maps for the remaining events. Results from this research will provide the tools to aid discussions with Wairewa Rūnanga and be used by the Endeavour Programme to develop a Mātauranga Māori approach to flood resilience. This PhD will also be done in conjunction with Assoc. Prof Fernando Mendez and Dr Ana Rueda Zamora at Universidad de Cantabria, Santander, Spain.