IQUA Autumn Symposium 2022

Friday 2nd December

Maynooth University

Research from the past

Impact for the future

Schedule

&

Abstract Booklet

Session 1: Quaternary in Ireland

09:00	**Registration Opens**
09:30	Welcome & Introduction to Impacts – Helen Shaw
09:45	Margaret Jackson, *Trinity College Dublin* *Mountain glacier fluctuations in the Glen of Imaal, Ireland, during the Last Glacial Maximum and Termination 1*
10:00	Michael Gibbons *A Turlough-bound hillfort in Doonowen, Coole Park, Co. Galway*
10:15	Sam Kelley, *University College Dublin* *Assessing the process and timescale of megagravel emplacement in a coastal boulder deposit, Annagh Head, western Ireland*
10:30	**Coffee Break**

Session 2: Sea-level

10:30	**Coffee Break**
11:00	**Keynote - Jason Kirby, *Liverpool John Moores University*** *Holocene relative sea-level changes in northwest Ireland: implications for glacio-isostatic adjustment models and contemporary sea-level change.*
12:00	Zoe Roseby, *Trinity College Dublin* *Two centuries of relative sea-level rise in Dublin, Ireland, reconstructed by geological tide gauge*
12:15	Fermin Alvarez, *Trinity College Dublin* *Surface distribution of modern intertidal saltmarsh foraminifera in Southern Ireland: Development of a regional dataset and implications for relative sea level reconstructions*
12:30	Maeve Upton, *Maynooth University* *Researching Historic Sea level Change: From mud to maths and more.*
12:45	**Lunch Break**

Session 3: International Quaternary

12:45	**Lunch Break**
14:00	Nick Scroxton, *Maynooth University* *Madagascar's Megafaunal Crash: combining paleoclimatology and paleoanthropology to uncover how, when, and why Madagascar's megafauna went extinct.*
14:15	Pete Akers, *Trinity College Dublin* *Nitrate isotopes provide new insight into Antarctic glacial mass balance*
14:30	Michelle McKeown, *University College Cork* *Can testate amoebae provide long-term baselines for monitoring peatland degradation and restoration success: applications from New Zealand to Ireland.*
14:45	Impact Workshop – Gill Plunkett and Graeme Swindles
15:30	IQUA Awards and Prizes, Closing Remarks
15:45	**Close**

09:45 *Mountain glacier fluctuations in the Glen of Imaal, Ireland, during the Last Glacial Maximum and Termination 1*

Margaret S. Jackson, Geography, School of Natural Sciences, Trinity College Dublin
Gordon R.M. Bromley, Geography and Palaeoenvironmental Research Unit, University of Galway
Brenda L. Hall, Earth and Climate Sciences, University of Maine
Shaun R. Eaves School of Geography, Environment and Earth Sciences and Antarctic Research Centre, Victoria University of Wellington
Adrienne Foreman, Geography and Palaeoenvironmental Research Unit, University of Galway

Recent work focused on offshore and near-shore glacial sediments in the northeastern North Atlantic provides insight into the dynamics, and ultimate demise, of the ice sheet that once covered Britain and Ireland during the Last Glacial Maximum. However, ground-truthed chronologic information on the terrestrial pattern of British-Irish Ice Sheet retreat remains relatively sparse, limiting our ability to reconstruct ice sheet response to Quaternary climate changes. Here we report a new glacial chronology from the Glen of Imaal, in Ireland's Wicklow Mountains, constrained with cosmogenic beryllium-10 surface-exposure ages of moraines. These data provide direct chronologic constraint on the extent and timing of mountain glacier fluctuations at the Glen of Imaal and indicate that mountain glaciation was most extensive at the site approximately 23 ka. Our preliminary data also suggest that glaciers disappeared from the catchment entirely during Heinrich Stadial 1. Because mountain glaciers can exist only in the absence of an overlying ice sheet, these data place a minimum limiting age on the timing of Irish Ice Sheet retreat in the region. These data offer new insight into the response of Ireland's cryosphere to past climate change and provide discrete terrestrial targets for ice sheet and glacial modelers.

10:00 *A Turlough-bound hillfort in Doonowen, Coole Park, Co. Galway*

Michael Gibbons

A unique turlough-bound hillfort has been identified in the karst lowland landscape of South Galway. This extraordinary monument was first mentioned in a one-line reference in a guide to Coole Park written by Professor John Feehan in the 1980s. It was then quietly forgotten. Subsequently, a short stretch (29m) of its ramparts was visited and described by archaeologists but they concluded that it was perhaps a "dummy fort", of "questionable antiquity". This interpretation may have been influenced by its extraordinary location, crowning the southern end of a limestone island rising almost ten meters over the surface of Lough Doo, Garryland and Coole lakes, as well as its situation within the extensive Gregory Estate at Coole near the town of Gort.

Recent research, published on the prehistoric settlement of the region, speculated that there may be an as-yet unrecognized Hillfort in the strategically important corridor bordering the Burren lowland. Doonowen may fill this gap. Recent fieldwork confirmed that the site is a heavily-fortified walled island that seems to have been destroyed in Antiquity. The ten acre fortified island is morphologically related to Bronze Age Hill forts, island cashels and promontory forts and represents an extraordinary adaption by prehistoric elites to a unique turlough-bound watery world.

10:15 *Assessing the process and timescale of megagravel emplacement in a coastal boulder deposit, Annagh Head, western Ireland*

Samuel E. Kelley, University College Dublin
Ronadh Cox, Williams College
Lee B. Corbett, University of Vermont
Paul R. Bierman, University of Vermont
Marc Caffee, Purdue University

We measure *in-situ* produced ^{10}Be from a wave-emplaced coastal boulder deposit (CBD) located on Annagh Head in County Mayo. CBD often contain megagravel weighing 10s to 100s of tonnes and are an indicator of high energy wave events. Recent work has demonstrated that these deposits are dynamic, with documented displacement of megagravel by storm waves at Annagh Head and other sites in western Ireland, though the long-term history of these deposits is poorly constrained. Here we make the first attempt to quantify CBD emplacement history using *in-situ* produced cosmogenic ^{10}Be from 20 quartz-bearing boulders. Our sampling focused on the largest boulders in the deposit, ranging from just over 1 to ~59 t mass. Initial results yield a range of ages encompassing much of the Holocene, indicative of a combination of pre-erosion bedrock inheritance, in addition to a protracted history of deposition and remobilization in response to wave action and rising post-glacial sea level. In total, this dataset provides a quantitative view on a dynamic feature of coastal landscapes, allowing for investigation into the geomorphic processes at work, as well as exploration of possible linkages to climate and landscape evolution.

11:00 **Keynote -** *Holocene relative sea-level changes in northwest Ireland: implications for glacio-isostatic adjustment models and contemporary sea-level change.*

Jason Kirby, School of Biological and Environmental Sciences, Liverpool John Moores University
Ed Garrett, Department of Environment, University of York
W. Roland Gehrels, Department of Environment, University of York

The late-Quaternary relative sea-level (RSL) history of Ireland is complex, positioned at the margins of the former British-Irish Ice Sheet, and subject to the influence of ice unloading and forebulge collapse. In the northeast of Ireland (closest to the centre of ice mass), geophysical models of post-glacial isostatic adjustment (GIA) indicate a falling RSL until the early Holocene, after which RSL rises to a mid-Holocene highstand. In contrast, the southwest of Ireland (within the area of forebulge collapse) is characterised by progressive RSL rise during the Holocene. For the region of northwest Ireland, there is a significant disparity between the pattern of RSL change simulated by GIA models and the available empirical data used to test and validate these reconstructions. However, there is a paucity of high-quality RSL data and therefore the evidence to support GIA model predictions of a mid to late-Holocene RSL highstand of between +0.5 and +2 m above present is equivocal.

This paper tackles this model-data mismatch with a new RSL record reconstructed from a salt-marsh sequence at Bracky Bridge, Donegal, spanning the last ca. 2500 years. A transfer function model is used to reconstruct the vertical position of sea level. This uses a regional diatom training set to quantify the indicative meaning and predict the palaeomarsh elevation of the core samples. A chronology is provided by a combination of 14C and 210Pb data, with sample specific ages derived from an age-depth model using a Bayesian framework.

The reconstruction shows ca.2 metres of RSL rise in the past 2500 years. This is not compatible with some previously published sea-level index points from the region, which are re-interpreted as freshwater/terrestrial limiting data. The results do not provide any evidence to support a mid-Holocene RSL highstand above present sea level. Whilst none of the available GIA models replicate the timing and magnitude of the late Holocene RSL rise in the reconstruction, those which incorporate a thick and extensive British-Irish Sea Ice Sheet provide the best fit. These findings have important implications for instrumental records of RSL change based on tide gauges which require correction for land motion, which in formerly glaciated regions is dominated by GIA.

12:00 *Two centuries of relative sea-level rise in Dublin, Ireland, reconstructed by geological tide gauge*

Zoë A. Roseby, School of Natural Sciences, Trinity College Dublin
Katherine Southall, School of Natural Sciences, Trinity College Dublin
Fermin Alvarez Agoues, School of Natural Sciences, Trinity College Dublin
Niamh Cahill, Hamilton Institute, Mathematics and Statistics, Maynooth University
Maeve Upton, Hamilton Institute, Mathematics and Statistics, Maynooth University
Gerard McCarthy, Irish Climate Analysis & Research UnitS, Maynooth University
Robin Edwards, School of Natural Sciences, Trinity College Dublin

Spatial patterns of relative sea level (RSL) provide critical insight into the drivers of sea level change. Saltmarsh-based 'geological tide gauge' (GTG) records of RSL change, supplement and extend records provided by instrumental tide gauges and have been used in combination with spatiotemporal modelling to distil global sea-level changes over the Common Era. Whilst a rich dataset is available from the eastern seaboard of North America, comparatively few GTG records exist from north-western Europe, and this spatial bias constrains the questions that can be addressed by this approach.

Ireland's location on the Atlantic edge of Europe means it is ideally placed to refine our understanding of sea level variability in the North Atlantic region. In this study, we test the application of the GTG approach in Ireland by reconstructing two centuries of RSL change in Dublin from duplicate sediment cores. Our records show strong agreement, indicating that RSL in Dublin rose by 33 cm since 1786 CE, at an average rate of 1.47±0.95 mm yr^{-1}. This is consistent with the regional rates of mean sea level rise inferred from tide gauge data. We discuss the implications of our results for the production of longer GTG records from Ireland and similar European contexts.

12:15 *Surface distribution of modern intertidal saltmarsh foraminifera in Southern Ireland: Development of a regional dataset and implications for relative sea level reconstructions*

Fermin Alvarez, School of Natural Sciences, Trinity College Dublin
Zoë A. Roseby, School of Natural Sciences, Trinity College Dublin
Robin J. Edwards, School of Natural Sciences, Trinity College Dublin

The reliable reconstruction of past relative sea-level (RSL) from foraminifera buried in high- saltmarsh sediment requires accurate species-height relationships to be developed from appropriate modern analogues. However, the species distribution from a saltmarsh is the product of numerous, complex interactions among the organisms and their environment where the specific composition and elevational range of foraminifera assemblages varies in time and space responding to the influence of different secondary variables. Understanding the variability of saltmarsh foraminiferal assemblages in the study area is a prerequisite for making informed choices about training set construction, but such data are currently lacking from the Irish coast.

We present the first regional training set of modern intertidal saltmarsh foraminifera from Southern Ireland, comprising twelve transects from eight saltmarshes, with the aims of: 1) determining whether saltmarsh foraminifera in this region are vertically zoned: 2) assessing whether these vertical distributions are consistent among sites. We conclude that tidal range appears to be the principal factor influencing inter-site assemblage variability, and that reconstructions based on a regional training set can be improved by careful screening of samples associated with saltmarsh cliffs, high energy regimes and areas of human modification.

12:30 *Researching Historic Sea level Change: From mud to maths and more.*

Maeve Upton, Hamilton Institute/ICARUS/ Maths and Statistics Department, Maynooth University
Prof Andrew Parnell, Maths and Statistics Department, Maynooth University
Dr Niamh Cahill, Maths and Statistics Department, Maynooth University

The 2021 Intergovernmental Panel on Climate Change report highlighted how rates of sea level rise are the fastest in at least the last 3000 years. As a result, it is important to understand historical sea level trends at a regional and local level in order to comprehend the drivers of sea level change and the potential impacts. The influence of different sea level drivers, for example thermal expansion, ocean dynamics and glacial – isostatic adjustment (GIA), has changed throughout time and space. Therefore, a useful statistical model requires both flexibility in time and space and have the capability to examine these separate drivers, whilst taking account of uncertainty. The aim of our project is to develop statistical models to examine historic sea level changes for North America's and Ireland's Atlantic Coast. For our models, we utilise sea-level proxy data and tide gauge data which provide relative sea level estimates with uncertainty. A Bayesian statistical approach is employed which uses Generalised Additive Models (GAMs) to examine separate components of sea level to be modelled individually and efficiently and for smooth rates of change to be calculated.

This work is part of the larger nationally funded Irish A4 project (Aigéin, Aeráid, agus Athrú Atlantaigh — Oceans, Climate, and Atlantic Change), funded by the Marine Institute. It aims to examine ocean and climate changes in the Atlantic Ocean. The project targets three aspects of the Atlantic: its changing ocean dynamics; sea level changes; and Irish decadal climate predictions. In the future, we will apply this modelling technique to produce a long term historical record for relative sea level change in Ireland.

Línte na Farraige is a collaborative outreach project which seeks to bridge the gap between the scientific community, the artistic realm and government bodies at a local and national level. In doing so, the project demonstrates to the general public the importance of the collective in mitigating climate change and future sea level rise. The project is inspired by the stunning light installations of Finnish artists Timo Aho and Pekka Niittyvirta. This art and science collaboration involved scientists from Trinity College Dublin and Maynooth University, the Climate Action Regional Offices (CAROs) and Local Authorities, as well as designers from Algorithm and Native Events. Línte na Farraige is a recipient of the inaugural Creative Climate Action fund, an initiative from the Creative Ireland Programme in collaboration with the Department of the Environment, Climate and Communications.

14:00 *Madagascar's Megafaunal Crash: combining paleoclimatology and paleoanthropology to uncover how, when, and why Madagascar's megafauna went extinct.*

Nick Scroxton, Irish Climate Analysis & Research UnitS, Maynooth University
Laurie Godfrey, Department of Anthropology, University of Massachusetts Amherst
Stephen Burns, Department of Geosciences, University of Massachusetts Amherst

The relative roles of climate change and human activity as triggers of megafaunal extinction are subject to widespread debate, including the Madagascar megafauna population crash between 700 and 900 CE. To assess competing influences on local flora and fauna we determined climate and land-use change using stable oxygen and carbon isotopes from stalagmites from Anjohibe cave, north-west Madagascar. A rapid land-use change at 900-1000 CE was not accompanied by a significant change in climate. Indeed, the period is likely one of the wettest of the last 2000 years. To investigate alternative possible causes of the megafaunal population crash we brought together evidence from numerous sources, including radiocarbon dates on subfossil bones, butchery records, genetic studies, and the new speleothem records. Both the rapid megafaunal decline and dramatic vegetation transformation in NW Madagascar coincide with a major transition in human subsistence on the island from hunting/foraging to herding/farming. Here we lay out a new hypothesis, called the "Subsistence Shift Hypothesis" to explain megafaunal decline and extinction in Madagascar. Counter-intuitively, the shift from hunting/foraging to herding/farming, plus settlement by new immigration groups, increased human population, hastening the crash of the megafaunal population despite reduced reliance on hunting.

14:15 *Nitrate isotopes provide new insight into Antarctic glacial mass balance*

Pete Akers, Geography, School of Natural Sciences, Trinity College Dublin

Antarctica's reservoir of glacial ice plays a key role in setting the global sea level as changes in its mass balance are linked to rises and falls in sea level throughout the Quaternary. Despite its importance to the global environment, our understanding of how the local mass balances of the Antarctic ice sheets spatially vary through time are limited by sparse observations. Reconstructions of past snow accumulation from deep ice cores usually rely upon water isotopes to infer atmospheric moisture capacity based on temperature, but this indirect method can be uncertain due to other environmental factors that affect water isotopic values. We developed an alternative proxy for local Antarctic surface mass balance using nitrogen isotopes of nitrate based on the isotopic fractionation that occurs when nitrate is lost from the snowpack through photolysis. Using modern observations from 114 sites across East Antarctica, we determined a transfer function to translate nitrate isotopic ratios preserved in ice cores into histories of snow accumulation change. Our proxy was successfully applied and verified in two ice cores from the Aurora Basin and WAIS Divide drill sites. This approach gives us a new geochemical tool for understanding past global changes and projecting how Antarctica may respond to future warming.

Michelle McKeown, *University College Cork*

14:30 *Can testate amoebae provide long-term baselines for monitoring peatland degradation and restoration success: applications from New Zealand to Ireland.*

Michelle McKeown, School of Biological, Earth & Environmental Sciences, University College Cork

The goal of this paper is to assess the sensitivity of peatland soil protozoa and vegetation to stress induced from anthropogenic activities with the aim of identifying a tool to provide rapid, reliable, and realistic analogues for peatland degradation. The paper focuses on lessons learned from New Zealand peatlands and have implications for assessing integrity of Irish peatlands and developing long-term baselines. Testate amoebae (single-celled free-living protozoa) are a powerful tool for assessing peatland integrity in response to changing ecological and hydrological conditions. We analysed vegetation structure, testate amoebae community assemblages and functional traits from two peatland complexes across a gradient of perturbation. We found that the community structure of plants and testate amoebae follow different patterns depending on disturbance regimes across the two peatland complexes, and that they are not surrogates of one another. We also demonstrate that test compression and aperture position are promising indicators of disturbance, likely related to peatland soil moisture. Inferences are made from other functional trait characteristics, but further work is needed to hone our understanding. Overall, we show that testate amoebae are valuable bioindicators to assess below-ground integrity of New Zealand's peatlands and a similar pattern is observed from blanket bogs in the southwest of Ireland.