IQUA

Cumann Ré Cheathartha na h-Éireann
Irish Quaternary Association
http://www.iqua.ie
@Quaternary_Irl
/IrishQuatAssociation

August 2023
NS: 70
ISSN: 0790-4096

Editor: Susann Stolze

1. Editor's Note

Dear IQUA members,

Welcome to IQUA newsletter No. 70.

This issue features abstracts of the IQUA Spring Meeting 2023, a report on the XXI INQUA Congress in Rome, dissertation abstracts from recent graduates, and a list of new publications from our community. Professor Francine McCarthy from Brock University in St. Catharine, Canada has been invited to present research conducted at Crawford Lake in Ontario whose sediments show the boundary of the Anthropocene. These findings published by her and colleagues of the Anthropocene Working Group this summer were covered by national and international media.

I would like to thank all who contributed to this edition.

Kind regards,

Susann Stolze, CSM, Colorado, August 2023
(sstolze@mines.edu)

2. Cúpla Focal

[lit.] A couple of words ... from the President

For some Irish Quaternary researchers, one of this summer's highlights was the XXI INQUA Congress in Rome that took place during the hottest July globally since records began. The event marked four years since the previous Congress was hosted by IQUA in Dublin, which funnily enough occurred during the previous warmest July on record. One might start to suspect some causality – thousands of delegates flying to attend an event and so contributing to global carbon emissions – if we didn't know that the climate system is a tad more complex than that. But it should make us think about the carbon footprint of our work, particularly given the field that we're in…

Much has happened in the intervening period since INQUA was held in Dublin, not least a major global pandemic. While COVID taught us that we can meet, collaborate and work without having to step outside our homes or offices, it also highlighted how much we cherish the opportunities to see other in the flesh and to interact organically, arguably an innate feature of our human nature that we cannot easily overlook. How then to balance the need to meet in person with the need to reduce our fossil fuel-dependent travel to scientific meetings? Perhaps Virtual Reality will help bridge the two in years to come, but we shouldn't forget that even data centres are part of the problem (particularly in Ireland), consuming large quantities of energy and water. While we await the growth of clean energy transport or a high-speed rail connection linking Ireland to continent Europe (we can dream!), we should tip our hats to those who braved days of travel using public transport to get to Rome, foregoing convenience for the greater good of the planet.

The next INQUA Congress will take place in Lucknow, India, scheduled for February 2027 to avoid the suppressive heat of the Indian summer. Given the "wettest ever" July we've just had in these parts, we might be forgiven for hoping in the meantime for a bit of an Indian summer of our own.

Gill Plunkett, IQUA President

3. IQUA Committee (2023)

President: Gill Plunkett, Queen's University Belfast

Secretary: Graeme Swindles, Queen's University Belfast

Treasurer: Mark Coughlan, iCRAG, University College Dublin

Postgraduate Rep: Adrienne Foreman, NUI Galway; Ryan Smazal, Dundalk Institute of Technology

4. IQUA Spring Meeting 2023

The IQUA Spring Meeting and AGM 2023 were held at the Cork Enterprise Centre, School of Biological, Earth and Environmental Sciences, University College Cork, on Saturday the 25th of March 2023. Following the welcome address and keynote talk by Eileen McCarthy, the morning part of the meeting was divided into three sessions addressing peatland monitoring and restoration, geochronology and geomorphology, and long-term relationships between climate, landscape, and humans. In the afternoon, a panel discussion led by Dr. Aaron Lim (University College Cork), Ms. Eileen McCarthy (QMEC Environmental), and Dr. Margaret Browne (Geological Survey of Ireland) was held on academia and industry. IQUA prize giving and final remarks concluded the official meeting which was followed by the annual general meeting.

Abstracts – Talks

Keynote Talk: What has a Quaternary Qualification ever done for you? Insights from a 25 Years in Geo-Consultancy

Eileen McCarthy [1,2,3]

[1] QMEC Environmental, Cork, Ireland
[2] School of Biological, Earth & Environmental Sciences / Environmental Research Institute, Distillery Fields, North Mall Campus, University College Cork (UCC), Cork, Ireland
[3] Irish Centre for Research in Applied Geosciences - iCRAG / SFI Research Centre for Energy, Climate and Marine - MaREI, University College Cork, Cork, Ireland

In higher latitude countries like Ireland, the legacy of the Quaternary means that Holocene and Pleistocene deposits are generally the first geology you "hit" and interact with in the ground when you investigate it. A robust understanding of how that "ground got there" and what to expect in terms of its stratigraphic sequence, spatial distribution, composition, contrast, and stress history sets you apart from others who look at the same ground and landscape from a non-Quaternary viewpoint.

In my disciplines of hydrogeology and engineering geology, this background in Quaternary geomorphology, stratigraphy and sedimentology allows me to predict hydraulic, geochemical and stress-response engineering behaviour. It gives me a head start in my conceptual model of understanding, which I then validate, modify and on occasion refute! through appropriately scaled site investigation and assessment. Utilising several examples from a 25-year career in geoscience consultancy, I hope to convince you of your unique selling points, should you wish to pursue a career in the non-academic sector.

Response of testate amoeba communities to peatland drain blocking

Callum Evans

Geography, School of Natural and Built Environment, Queen's University Belfast, Belfast, Northern Ireland
Corresponding author: cevans12@qub.ac.uk

Peatlands are increasingly important habitats due to their sizeable carbon stores. However, anthropogenic activity leave peatlands with a substantial management challenge. Degradation of peatland habitats through land-use change is often restored by re-wetting. Research into how this management affects peatland microbial communities is limited. Testate amoebae (single-celled protists) are commonly used for palaeohydrological reconstruction from peatlands – here we use these organisms as contemporary bioindicators of restoration success on three small raised bogs in the UK (Cranny Bogs, Northern Ireland). Two treatments (dammed and control) presented complex but meaningful results following management intervention. Though complicated, results imply wetter conditions following restoration, where routine monitoring was unable to suggest a trend this early after restoration. Following management: diversity increased generally across both treatments; unambiguous wet indicator taxa (e.g., *Archerella flavum*) were observed in increasing abundance at dammed treatment sites; and reconstructed water-table depths showed wetter conditions in dammed treatment sites. However, antecedent conditions obscured multivariate analysis leading us to reveal no significant community-level response to variables before, immediately following, or many months after restoration. Nevertheless, this study emphasizes the potential of an indicator-taxa based approach to applying testate

amoebae as contemporary bioindicators of peatland restoration – particularly on short-term timescales immediately following restoration.

Using Tellus Airborne Radiometric data to update the national peatland map in Ireland

Dave O'Leary [1]*, J. Connolly [2], L. Gilet [2], J. Hodgson [3], E. Daly [1]

[1] HYRES Research Group, Earth and Ocean Sciences and Ryan Institute, College of Science and Engineering, University of Galway, Galway, Ireland
[2] Department of Geography, Trinity College, Dublin, Ireland
[3] Geological Survey, Ireland (GSI), Booterstown, Blackrock, Co. Dublin, Ireland
* Corresponding author: d.oleary1@nuigalway.ie

Peatlands are important carbon holding habitats. Drained peatlands emit carbon via decomposition of stored material. National climate plans require knowledge of peatland spatial distribution nationally.

Peatland maps are created in many ways including optical satellite remote sensing or traditional mapping techniques. However, remote sensing cannot detect peatlands under landcover such as forest or grassland. Traditional maps are often created from sparse in-situ data which do not allow for accurate measurement of peatland boundaries.

Radiometrics, which measures environmental radiation, is suited to peatland studies. Modelling of radiometric attenuation shows a statistical difference in data recorded over peat, compared to a non-peat soil. Mineral soils contain geological material which acts as a source of radiation and peat is generally not considered a source of radiation. Peat tends to be saturated and water acts to attenuate the radiation also. These effects combined means that peatlands appear as a "low" radiometric signal in the landscape.

The Tellus survey (GSI) aims to acquire airborne radiometric data nationally in Ireland. This study uses these data combined with machine learning classification, to identify peatlands under modified landcover and update peatland maps. The results may update national and international inventories of peatlands area and inform European policy.

Fungi and other microorganisms as indicators of peatland response to climate change, health, and restoration

Rebecca J. Rivera*, Fraser J.G. Mitchell, Mathew Saunders, Carla J. Harper

Botany Department, School of Natural Sciences, Trinity College Dublin, Dublin 2, Ireland
* Corresponding author: riverar@tcd.ie

Peatlands are culturally, economically, and ecologically important ecosystems in Ireland. The extraction and draining of Ireland's peatlands over several centuries have negatively impacted peat biodiversity, in particular, the microorganisms. Climate change has led to a need for policies and new practices focusing on the protection and restoration peatlands. Reliable proxies to measure the effect and/or progress of peatland restoration are complicated and difficult to establish, especially without a comparable 'baseline' of microbial biodiversity. Fungi have been shown to be essential to peatland health; they are fundamental to biodiversity, carbon cycle dynamics and decomposition. Irish Quaternary peat deposits have yielded a wealth of information to palynology studies of peatland ecosystems; however, these studies are primarily based on pollen analyses. Non-pollen palynomorphs (NPPs) have been shown to be useful proxies as palaeoecological indicators and may prove to be a powerful tool that provide additional insights into palaeoecological studies. This research examines the diversity of NPPs, with a primary focus on fungi, of Quaternary peat deposits with aims to establish a baseline of microbial biodiversity, as well as target microbial restoration communities. NPP data analysis can help reconstruct environmental changes over time, which is fundamental to the maintenance and restoration efforts of peatlands.

Looking Up: A multidisciplinary project on glacial geology and early prehistoric heritage in the Cairngorm Mountains

Sam Kelley [1]*, Alice Doughty [2], Micheál Butler [3], Martin Moucheron [3], Graeme Warren [3]

[1] School of Earth Science, University College Dublin, Dublin, Ireland
[2] School of Earth and Climate Science, University of Maine, USA
[3] School of Archaeology, University College Dublin, Dublin, Ireland
* Corresponding author: sam.kelley@ucd.ie

Uplands are rapidly changing areas of the European landscape. Landscape and environmental change in highland regions is driven by a host of anthropogenic forces, such as reforestation/rewilding, tourism, and human-induced climate change. Accelerated landscape and environmental change have direct effects on natural and cultural heritage found in upland areas, resulting in poorly understood consequences. This lack of understanding stems from a gap in knowledge regarding the location and extent of cultural heritage in highland areas.

The Looking Up project utilizes glacial geology, Quaternary geochronology, and archaeology to

generate predictive models of cultural heritage linked to early Holocene hunter-gatherer use of the Cairngorm region, the highest upland area in Brittan and Ireland. Our models assess the potential of cultural heritage across a highland landscape, a potential tool for landscape management. Here, I will present the progress to date on the Quaternary geologic side of this project, which explores the timing and style of deglaciation of the Cairngorm plateau and adjoining corries. Additionally, I will highlight the role that Quaternary geologic data plays in this multidisciplinary project.

A geomorphological investigation into glacier change since the Little Ice Age (LIA) in the Brooks Range, Alaska, USA

Jack Mason [1]*, Robert McNabb [1], Paul Dunlop [1], Bethan Davies [2]

[1] School of Environmental Sciences, Ulster University, Coleraine, Northern Ireland
[2] School of Geography, Politics and Sociology, Newcastle University, Newcastle-Upon-Tyne, Tyne and Wear, England
* Corresponding author: mason-J3@ulster.ac.uk

Global and regional estimates of glacier mass and area change in high latitude areas are poorly constrained prior to 2000 due to a lack of data. This impedes our ability to comprehend and contextualise observed glacier mass loss, particularly when investigating changing rates of mass loss. This can be resolved by extending the glacial record back in time, to improve understanding of how glaciers have changed in high latitude regions under a longer-term time series of climatic change.

The Brooks Range, Alaska is a dry, high latitude region in the Arctic that has been understudied in the past. The glaciers are all land-terminating, making them good proxies to investigate the impact of climate change in the region.

This study aims to reconstruct glacier behaviour since the "Little Ice Age" (LIA) by reconstructing the Brooks Range LIA glacial maximum and comparing it to various points in time between then and 2022. We use mapped glacial features to infer LIA glacier outlines and calculate their approximate area and ELA. In some areas, glacier outlines digitised from topographic maps are available and were used as timestamps to correlate glacial features with their approximate age and evaluate changing rates of glacier wastage between LIA inferred outlines and 2022 outlines. We derive 2022 glacier outlines from Sentinel-2 imagery, using a band ratio method to automatically identify glaciers followed by vectorisation and manual editing to produce a Brooks Range glacier database. Generation of these outlines enables quantification of glacier area change and ELA change from the LIA to 2022.

Our new geomorphic maps will allow us to constrain rates of change and analyse how Brooks Range glaciers are responding to changing climatic forcings in the region. This will enable insights into the style and manner of the neoglaciation and deglaciation in the Brooks Range.

Environmental forcing by submarine canyons: evidence between two closely situated cold-water coral mounds (Porcupine Bank Canyon and Western Porcupine Bank, NE Atlantic)

Luke O'Reilly [1,2]*, Robin Fentimen [3], Felix Butschek [2], Jürgen Titschack [4,5], Aaron Lim [1,6], Niamh Moore [7,8], O.J. O'Connor [7,8], John Appah [1], Kimberley Harris [9], Torsten Vennemann [10], Andrew J. Wheeler [1,11]

[1] School of Biological, Earth & Environmental Sciences / Environmental Research Institute, Distillery Fields, North Mall Campus, University College Cork (UCC), Cork, Ireland
[2] Green Rebel, Green Rebel, Penrose One, Penrose Dock, Cork, Ireland
[3] ENS Lyon (Dept of Earth Sciences, Ecole Normale Superieure de Lyon, 46 allée d'Italie, Lyon, France
[4] MARUM – Center for Marine Environmental Sciences, University of Bremen, Bremen, Germany
[5] Senckenberg am Meer, Marine Research Department, Wilhelmshaven, Germany
[6] School of the Human Environment, University College Cork, Cork, Ireland
[7] Department of Radiology, Cork University Hospital (CUH), Wilton, Cork, Ireland
[8] Department of Radiology, University College Cork, Cork, Ireland
[9] DP Energy Ireland Ltd, Mill House, Buttevant, Co. Cork, Ireland
[10] IDYST – Institute of Earth Surface Dynamics, University of Lausanne, Lausanne, Switzerland
[11] Irish Centre for Research in Applied Geosciences - iCRAG / SFI Research Centre for Energy, Climate and Marine - MaREI, University College Cork, Cork, Ireland
* Corresponding author: luke.oreilly@greenrebel.ie

Cold-water coral (CWC) mounds within the Porcupine Bank Canyon in the NE Atlantic are mostly clustered along the canyon lip, with individual disconnected mounds nearby on the western Porcupine Bank. This study utilizes a novel method of remotely operated vehicle-mounted vibrocoring to acquire cores from both sites, enabling precise sampling of the closely situated areas. Radiometric ages constrain the records from the early to mid-Holocene (9.1 to 5.6 ka BP), and 3D segmented computer tomography was used to capture mound formation stages. The cores were further examined

using stable isotopes and benthic foraminiferal assemblages to understand the paleoenvironmental variation that influenced CWC mound formation. Results show that regional climatic shifts define the environmental conditions that allow positive coral mound formation. Coral mound aggradation rate was comparable to other Holocene CWC mounds off western Ireland, and the aggradation rate was higher adjacent to the Porcupine Bank Canyon than on the western Porcupine Bank. The study hypothesizes that coral mound formation in the region is likely controlled by an interplay between enhanced shelf currents and the existence of the Eastern North Atlantic Water-Mediterranean Outflow Water-Transition Zone. The geomorphology of the canyon promotes upwelling of these water masses that are enriched in particles, including food and sediment supply. These observations highlight the role that submarine canyons play in influencing macro and micro benthic fauna distributions and emphasize the importance of their conservation.

A palaeoenvironmental perspective on transhumance in the Mourne Mountains, Northern Ireland

Helen Essell *, Gill Plunkett

Archaeology & Palaeoecology, School of Natural and Built Environment, Queen's University Belfast, Belfast, Northern Ireland
* Corresponding author: hessell01@qub.ac.uk

Uplands are widely perceived as marginal within the landscape. This is not solely due to their geographical isolation; upland environments are highly susceptible to the negative effects associated with periods of climatic deterioration. A rich archaeological record and historical evidence, however, attest to human presence in uplands through the past. In the Medieval and early post-Medieval periods, uplands are thought to have provided space for transhumance, a practice involving the seasonal movement of people and livestock to higher ground to exploit land for grazing in the summer months. The precise nature of activity and chronology of occupation at associated booley huts is poorly understood. Here, we explore transhumance in the context of the Mourne Mountains, Northern Ireland. Through palynological analysis of blanket peat sequences extracted from the vicinity of booley huts, this study explores how settlers shaped and interacted with their environment. We identify Later Medieval to Early Modern settlement at two sites characterised by grazing concurrent with cereal cultivation, challenging narratives of transhumance simply being associated with herding. These findings provide insights into human-environment interactions in 'marginal' upland landscapes, informing adaptation strategies for present and future populations who face environmental pressures similar to those of societies in the past.

The Bronze Age population in eastern Tarim Basin (Lop Nur), northwest China, and their subsistence environment

Kangkang Li [1,2]*, Xiaoguang Qin [1], Gill Plunkett [2]

[1] Key Laboratory of Cenozoic Geology and Environment, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China
[2] Archaeology and Palaeoecology, School of Natural and Built Environment, Queen's University Belfast, Belfast, Northern Ireland
* Corresponding author: k.li@qub.ac.uk

The Bronze Age of the extremely arid Tarim Basin, northwest China, is well known for its well-preserved desiccated corpses from the Lop Nur region associated with the Xiaohe Culture (ca. 2100–1400 BCE). The Xiaohe complex mainly consists of three iconic funeral sites and one settlement across the basin, which are surrounded by a harsh desert environment. The material culture of Xiaohe culture, e.g., decorated grass-woven basket, boated-shaped coffins and evidence of animal husbandry (faunal remains and milk products), indicates a successful adaptation at that time to an inhospitable terrain. Archaeobotanical remains (e.g., grains of wheat and common millet) suggest that the Xiaohe populations interacted with other communities to diversify their subsistence base. However, whole-genomic sequencing of ancient individuals from Xiaohe cemeteries show that they are descended from a genetically isolated population. There has been proposed that the decline of the Xiaohe culture could include a long-distance westward movement of populations along the river. This presentation aims to introduce the Bronze Age Tarim Basin society and its site-level living environment. Subsequently, we will consider whether environmental and climatic changes influenced the rise and fall of the Xiaohe culture.

Investigating the long-term effects of agriculture on biodiversity in the uplands of Scotland

Louise Smith [1]*, Jeffry Oliver [1], Gill Plunkett [2], Kate Britton [1]

[1] Department of Archaeology, School of Geosciences, University of Aberdeen, Aberdeen, Scotland
[2] School of Natural and Built Environment, Queen's University Belfast, Belfast, Northern Ireland
* Corresponding author: l.smith1.22@abdn.ac.uk

A decline in biodiversity has been observed globally and linked to a variety of human practices. Agriculture has a very strong and lasting impact on biodiversity and the effects of current agriculture on plant biodiversity have been well studied. However, the impacts on past biodiversity are less well understood. In the 18th and 19th centuries Scotland experienced rapid changes in agricultural practices leading to a large reclamation of land and the movement to more marginal areas such as the uplands. These changes in management of the uplands were more intense than previous human influences on the area.

The project aims to join the use of traditional archaeological and ecological methods. The data the project will generate will originate from an analysis of historical biodiversity via a palynological investigation and the current biodiversity via plant surveys and species analysis. The combination of these methods will enable us to understand the impact of post-medieval settlement on the biodiversity of upland areas.

Land-use and climate changes during the Irish Bronze Age: what can the nitrogen cycle tell us?

Sarah Ferrandin [1]*, Gill Plunkett [1], Kate Britton [2], Neil Ogle [1]

[1] School of Natural and Built Environment, Queen's University Belfast, Belfast, Northern Ireland
[2] Department of Archaeology, School of Geosciences, University of Aberdeen, Aberdeen, Scotland
* Corresponding author: sferrandin01@qub.ac.uk

Isotope zooarchaeological research in Ireland has identified a sustained positive shift in the nitrogen stable isotopic values of faunal remains during the Middle to Late Bronze Age (1750–800 BCE). This has been hypothesised to have been triggered by an intensification of farming, representing a potential indelible human footprint in the Irish geologic record (Guiry et al., 2018, Science Advances). However, whether these region-wide changes were triggered by anthropogenic factors or by natural climatic changes has not yet been tested.

This paper will present preliminary results from a multi-proxy analysis of sedimentary records that seeks to establish whether a region-wide N isotope change was triggered by human activity or climate. Ombrotrophic peat bogs obtain their nutrients from the atmosphere, meaning their stable isotopic values should reflect climatic fluctuations, unlike lake sediments, which should reflect both climate and land-use changes. In addition to carbon and nitrogen stable isotope measurements, pollen and testate amoebae analyses are also used to reconstruct land-use, bog surface wetness and water-table fluctuations. Through this multi-proxy study, we explore the inter-relationships between the nitrogen cycle, climate and human activity and consider whether there is a case for an early Anthropocene in Ireland.

Abstracts – Posters

High-resolution glacial geomorphology of the Antrim Plateau, northeast Ireland

Alex M. Clark [1,2]*, Sam Roberson [3], Simon P.E. Blockley [1], Adrian P. Palmer [1], Magret Damaschke [2], Bethan J. Davies [4]

[1] Centre for Quaternary Research, Royal Holloway University of London, Egham, Surrey, England
[2] British Geological Survey, Keyworth, Nottinghamshire, England
[3] Geological Survey of Northern Ireland, Ballymiscaw, Belfast, Northern Ireland
[4] School of Geography, Politics and Sociology, Newcastle University, Newcastle-Upon-Tyne, Tyne and Wear, England
* Corresponding author: alexander.clark.2015@live.rhul.ac.uk

The Antrim Plateau, northeast Ireland, lay broadly at the confluence of the North Channel, Malin Sea, and Irish Sea Ice Streams between c. 23–16 ka BP. A large local ice dome also operated during this time, resulting in the drumlinsation of the Bann Valley. A combination of climatic and dynamic factors then drove the complete collapse of these ice streams and regional ice centres. However, with the current suite of chronological and geomorphological evidence, the true timing and nature of this disintegration remains elusive, precluding a detailed understanding of ice-climate-landscape interactions at ice stream onset zones in a rapidly receding Irish Ice Sheet. New chronological data and a reassessment of geomorphological maps are required to help rectify this.

Our poster presents >8,000 glacial landforms on the Antrim Plateau currently mapped as part of an effort to understand palaeo-ice sheet dynamics in unparalleled detail in northeast Ireland. Landforms were mapped using a 0.4 m resolution digital surface model and verified through ground-truthing campaigns. We begin to reveal regional complexities in ice flow direction, extensive glaciofluvial and subglacial meltwater activity, and new ice limits. Mapping has also proved essential in identifying key palaeo-lake basins where tephrochronological and stratigraphic analyses are underway.

Quaternary geology of the Celtic Sea Shelf: key understandings for offshore windfarm development in Ireland and UK

Susanth Sundaran [1,2]*, Riccardo Arosio [1], Andrew Wheeler [1], Martin Stokes [2], Ian Selby [2]

[1] School of Biological, Earth & Environmental Sciences, University College Cork, Ireland
[2] School of Geography, Earth and Environmental Sciences, University of Plymouth, England
* Corresponding author: ssundaran@ucc.ie

Detailed investigation of the Quaternary and pre-Quaternary geology of the Celtic Sea Shelf is necessary to constrain engineering plans for wind turbine foundations. The Celtic Sea Shelf, between SE Ireland and SW Britain, is a key area for the future development of renewable energy with significant industry attention given to windfarm development by the respective governments. The inner shelf contains a number of (palaeo-) channels forming a large drainage network cutting the outcropped bedrock while the mid and outer shelf comprises Quaternary deposits above Miocene mudstone and siltstone. Irrespective of the bedrock geology, the Celtic seafloor has specific challenges for windfarm development due to its recent shaping by past glaciofluvial processes. Sea-level lowering and ice (re)advances resulted in multiple subaerial exposures of the seafloor and the development of a river/tunnel valley network, linked to the higher landmasses of SE Ireland and SW Britain and the NE-SW fluctuating main glacier ice fronts. The palaeochannels sediment has significant erosion and mobilization potential affecting the burial/exhumation of seafloor cables and the stability of the seafloor structures anchoring/tethering onto and into the seafloor, hence mapping the extent of these features is important for geohazard assessment. The research will accordingly develop and apply high-resolution digital seafloor geomorphological and sub-surface mapping approaches to characterize the palaeo-channels. Mapping outputs will be integrated with existing geophysical and geotechnical engineering datasets to construct 3D seafloor ground models for use by engineers, habitat ecologists, and other net zero and blue economy stakeholders.

A Temporal Assessment of Antimicrobial Resistance in the Environment (TARE)

J. O'Donovan [1,4]*, C. Chique [2,3], J. O' Dwyer [2,3,4], M. McKeown [2,3], A. Potito [1,4]

[1] School of Geography, Archaeology and Irish Studies, and Ryan Institute, University of Galway
[2] School of Biological, Earth and Environmental Science (BEES), University College, Cork, Ireland
[3] Environmental Research Institute, University College Cork, Cork, Ireland
[4] Irish Centre for Research in Applied Geosciences, University College Dublin, Dublin, Ireland
* Corresponding author: j.odonovan10@nuiglaway.ie

One of the biggest global threats to human health is antimicrobial resistance. The TARE project assesses:

i) The impact of the shift in Irish agriculture - from a traditional crop/pasture rotational system to modern and intensive pastures, and

ii) The impact of human sewage discharge on both faecal pollution (via *E. coli*) and the antimicrobial susceptibly profiles of faecal bacteria in the aquatic environment.

This will be investigated by obtaining representative core samples collected using a piston corer spanning the last ~ 80 years from the 3 basins of Lough Muckno, Co. Monaghan, a lake influenced by significant urban and agricultural environmental pressures. *E. coli* will be cultured at depth intervals in each core and antimicrobial susceptibility analyses on the cultured *E. coli* isolates will be performed, producing a high-resolution and chronologically constrained record of antimicrobial resistance (AMR). TARE aims to increase our scientific understanding of the historical and current levels of faecal pollution, and concurrently AMR in an anthropogenically impacted surface waterbody and identify the trends, drivers and mediating factors which lead to AMR development. Results will provide a critical evidence-base for informing current and future policy relating to environmental pollution and human health. TARE is the first study to assess the evolution of antibiotic resistance from a spatiotemporal perspective in an environment impacted by both human and agricultural waste.

Fungi and other microorganisms as indicators of peatland response to climate change, health, and restoration

Rebecca J. Rivera *, Fraser J.G. Mitchell, Mathew Saunders, Carla J. Harper

Botany Department, School of Natural Sciences, Trinity College Dublin, Dublin 2, Ireland
* Corresponding author: riverar@tcd.ie

Peatlands are culturally, economically, and ecologically important ecosystems in Ireland. The extraction and draining of Ireland's peatlands over several centuries have negatively impacted peat biodiversi-

ty, in particular, the microorganisms. Climate change has led to a need for policies and new practices focusing on the protection and restoration of peatlands. Reliable proxies to measure the effect and/or progress of peatland restoration are complicated and difficult to establish, especially without a comparable 'baseline' of microbial biodiversity. Fungi have been shown to be essential to peatland health and should be considered as important ecological factors of processes, because they are fundamental to biodiversity, carbon cycle dynamics and decomposition. Non-pollen palynomorphs (NPPs) have been shown to be useful proxies as palaeoecological indicators and may prove to be a powerful tool in predicting how peatland ecosystems will respond to climate change. This research examines the diversity of NPPs, with a primary focus on fungi, of peatlands in various stages of restoration to establish a baseline of microbial biodiversity. The NPP data can be used to show how microbes responded and adapted to past climate change events, as well as future projections. Moreover, results will provide examples of target microbial restoration communities and a new proxy for evaluating peatland restoration progress. Peatlands are important ecosystems as they are natural carbon storers, thus their restoration and maintenance will be instrumental in tackling climate change.

5. XXI INQUA Congress

Helen Essell

Archaeology and Palaeoecology, School of Natural and Built Environment, Queen's University Belfast

From 14–20 July 2023 as part of an eight-person strong delegation of ECRs from Queen's University Belfast, we attended the 21st Congress of the International Union for Quaternary Research (INQUA) at Sapienza University of Rome, Italy.

The Congress began with and icebreaker event in the Botanical Garden of Rome. On touring the gardens the stark difference to the Irish vegetation we are accustomed to was clear! We saw specimens from around the world, of note were the cherry blossoms in the Japanese Garden and *Ginkgo biloba* in the medicinal herb collection. This was also a good opportunity to meet others whose presentations we would later see.

The conference itself was set in the grounds of Sapienza University. Italian President, Sergio Mattarella, commenced proceedings in the Opening Ceremony where among formalities, we were treated to Italian opera.

With 1480 oral and 2114 poster presentations, a plethora of topics within Quaternary Science were represented in the Congress. As a group of Archaeologists, Palaeoecologists and Geographers, we primarily attended presentations on human-environment dynamics, ecosystem management, and carbon sequestration. We also attended talks on topics beyond our current research, such as the Asian monsoon, mammoth de-extinction, and Pleistocene pygmy elephants, which brought attention to new areas of Quaternary science that may be of interest for future research. The Irish Quaternary was well represented too: from peat, lake and loess deposits to geological mapping and modelling.

For many in our group, this was the first large conference we had attended. Between us, we gave a mixture of poster and oral presentations which provided a valuable opportunity to practice disseminating our research and get feedback from experts in our respective fields. Engaging with other attendees also opened networks for future collaboration and knowledge exchange.

The theme of the Congress was 'Time for Change'. It was encouraging to see so many people embrace the critical issues that society and the environment are currently facing, using the past to understand and our potential futures and what they should/could look like. Nevertheless, this felt somewhat ironic given the weather throughout the conference. Much of southern Europe was experiencing the effects of a heatwave in mid-July and on day five of the Congress temperatures in Rome reached a record high of 41.8°C, exceeding the previous record set last summer by 1.1°C. Although this made us evermore grateful that the majority of the Congress was held in air-conditioned rooms, it is testament that now is indeed the 'Time for Change' if the effects of anthropogenically induced climate change are to be curtailed.

Members of our group attended mid- or post-Congress fieldtrips to: Albano crater lake, Italy's deepest crater lake where seismic swarms are frequent; the Roman fish tanks at Punta della Vipera and Castrum Novum, which provides a precise measure of local sea level of 2000 years ago due to glacio-hydro isostatic adjustment; and Dalmati, Croatia, to the lake and karst landscapes in Krka and Kornati National Parks.

While in Rome, we took the evenings to take in the treasure trove of archaeology and history of the city. Highlights were the Colosseum, Roman Forum,

Pantheon, Trevi Fountain, Domus Aurea, and the Vatican City. We also enjoyed the local cuisines, consuming what now feels like a year's worth of pizza and pasta!

Overall, INQUA 2023 was an academically enriching experience and Rome provided the perfect backdrop to put societal and environmental change into perspective. Anticipation is high for XXII INQUA in Lucknow, India, in 2027 which promises to be an enriching experience thanks to the expansive Quaternary geology of the Indian subcontinent.

5. Recent Graduates

Michelle Curran

University of Galway
PhD defended in December 2022

A Palaeoceanographic Investigation of Abrupt Climate Change in the Eastern North Atlantic Under Different Boundary Conditions

Modern warming of the Arctic Region has been linked to extreme weather events in the Northern Hemisphere, including severe winters, increased precipitation, summer heatwaves, and increased storminess. Further, sea-ice decline and enhanced background melting of the Greenland Ice-Sheet may affect the Atlantic Meridional Overturning Circulation (AMOC) by altering surface water buoyancy at deep-water formation sites. However, our observation and historical data series are too short to ascertain the impact Arctic warming might have on the climate system, resulting in a gap in our knowledge and uncertainty on how the climate system may respond to future warming. Contradictory conclusions between observations and model studies add to these uncertainties. For example, many models predict a reduction in deep-water formation during times of enhanced freshwater input, while palaeo evidence suggests vigorous deep-water formation despite freshening, highlighting our incomplete understanding of the mechanisms driving climate change.

Past climate archives provide us with a tool to assess the ocean-atmosphere climate system during times of enhanced high-latitude warming. However, as the climate system responds not only to direct forcing but also to the forcing history (i.e., boundary conditions), it is crucial we examine the climatic response to enhanced high-latitude warming under various boundary conditions. This research focuses on three new palaeoceanographic investigations during periods of Arctic warming. Two focus on interglacial boundary conditions that were warmer than present, and the third investigates a deglacial period when the Arctic was warming but the boundary conditions were in transition from glacial to interglacial states. This research thus provides an opportunity to assess how different boundary conditions modulated the climate response of the North Atlantic Region.

The first investigation focuses on the transition from the warmer than present Holocene Thermal Maximum (HTM) (~4–7 ka) to the cooler Late Holocene. The HTM was characterised by significantly lower sea-ice extent at high northern latitudes and warm sea surface temperature and surface air temperature anomalies in the Barents Sea and subpolar North Atlantic Region. This was followed by a transition to high-latitude cooling and sea-ice growth during the Late Holocene. Using geochemical proxies to reconstruct past movements of the Irish Shelf Front, this study reveals how past changes in atmospheric circulation resulted in enhanced storm magnitude and frequency for the UK and Ireland during warmer than present climates of the HTM.

The second study focuses on an abrupt climate event during Marine Isotope Stage (MIS) 11 (~424–403 ka) when prolonged warming of the Arctic and continuous background melting of the Greenland Ice-Sheet led to a cold, and relatively fresh surface ocean in the Nordic Seas. Analysing both surface ocean hydrography and deep-water flow strength, preserved in the same sample from a sediment core collected in the eastern North Atlantic, allows us to assess the relative timing of the onset, duration, and

recovery of a surface and deep-water climate event. Interestingly, despite the addition of freshwater, Nordic Seas Deep-Water formation remained strong during early MIS 11, supporting the hypothesis that deep-water formation may not be as susceptible to future Greenland Ice-Sheet melting as previously thought. However, our analysis reveals deep-water flow strength weakened when the freshwater lens over the Nordic Seas drained into the subpolar North Atlantic, also causing an abrupt surface cooling event.

Finally, the third study focuses on the Glacial-Interglacial transition, Termination 5–TV (~430–424 ka), when the demise of the largest continental ice-sheets of the late Quaternary occurred under relatively weak orbital forcing. Here, the paired surface and deep-water proxies enables an assessment of the relative timing of surface water properties and deep circulation changes (i.e., lead/lags) at our core site in the eastern North Atlantic. Specifically, our analysis reveals that the primary onset of the deglaciation occurred in the Nordic Seas rather than at low-latitudes, since the reinvigoration of overflows in the Nordic Seas at the end of MIS 12 precedes the recovery of the surface ocean by several centuries.

Both the investigations on MIS 11 and TV suggest that fluctuations in Nordic Seas Deep-Water formation are precursors to abrupt climate change in the eastern North Atlantic. Further, both studies identify the density gradient between the Nordic Seas and the subpolar North Atlantic as crucial in maintaining overflows, during both warm and cold climates. Thus, Nordic Seas Deep-Water may not be as susceptible to freshwater forcing as previously hypothesised. Moreover, enhanced advection of cold, and relatively fresh Polar Waters to the subpolar North Atlantic can rapidly initiate an abrupt cold event, within centuries, during both glacial and interglacial conditions. This research improves our understanding of how the climate system responds to enhanced high-latitude warming under different boundary conditions. Further, it highlights that boundary conditions are fundamental to how the climate responds. This is important going forward and must be considered when climate models are being developed.

Dave O'Leary

Ryan Institute and Department of Earth and Ocean Sciences, School of Natural Sciences, University of Galway
Supervisor: Dr. Eve Daly
PhD completed in October 2022

Mapping soil using neural network machine learning and remotely sensed geoscience data; a study in peat

Several concepts exist in the disciple of data analysis that are often unknowingly used in geosciences. Specifically, the concepts related to Big Data, Data Assimilation, Digital Soil Mapping and Exploratory Data Analysis. Recently the availability of large geo-spatial data sets, such as satellite remote sensing, has meant these concepts are appearing more and more in geoscience literature, however any explanation or explicit understanding of these concepts is often missing. In this thesis, these concepts are highlighted and applied to several large geo-spatial datasets in the context of peatland identification and intra-peatland mapping of physical properties. Peatlands make up ~ 3 % of the land surface globally and account for ~ 10–20 % of all soil carbon, making these soils globally important in the carbon cycle. Drained and modified peatlands account for significant emissions of carbon to the atmosphere. Peatland rehabilitation aims to return these peatlands to their natural state, making them carbon neutral, or even carbon negative in time, however advances in peatland identification and delineation are needed to update national and global peatland inventories and meet national reporting obligations. The geo-spatial datasets used in this thesis are optical satellite remote sensing and airborne radiometric. Modern machine learning neural network methods are used to firstly identify and update peatland boundaries and secondly to visualise peatland physical property (landcover and soil moisture) variation within a peatland site. The methods developed here follow the principles of data analysis and have applications outside the scope of this thesis.

6. Field Meeting to County Louth

Gill Plunkett

Geography, Archaeology and Palaeoecology, School of Natural and Built Environment, Queen's University Belfast
g.plunkett@qub.ac.uk

Due to scheduling difficulties, the IQUA Field Meeting to County Louth led by Gill Plunkett and Ryan Smazal has been postponed until Spring 2024. The provisional date of the meeting is 22–24 March 2024. Further information will be circulated in due course.

7. Invited Contribution

Are we living in the Anthropocene… and since when?

Francine McCarthy (AWG Member since 2019)

Department of Earth Sciences, Brock University, St. Catharines, Ontario, Canada
fmccarthy@brocku.ca

In 2009, the International Subcommission on Quaternary Stratigraphy (SQS) commissioned a working group to investigate whether the "Anthropocene" had substance as an epoch, as Nobel laureate Paul Crutzen had insisted nine years earlier. As an atmospheric chemist, he argued that – from an Earth Systems Science perspective – human impact had altered the planet well beyond the norms of the previous ~ 12,000 years, so we were no longer living in the Holocene Epoch. The question remained – when had this tipping point occurred? Anthropocene Working Group (AWG) members then debated the existence of, and merits of potential bases for, this possible new epoch, and at the International Geological Congress in 2016, they voted overwhelmingly to search for a Global boundary Stratotype Section and Point (GSSP) to define the Anthropocene as an epoch, with a base in the mid-20th century. A globally synchronous transition from the Holocene state was identified at all twelve sites considered by the AWG as potential Anthropocene candidates, driven by multiple factors including anthropogenic emissions of CO_2 during the Great Acceleration.

Beginning in 2018, I (together with Tim Patterson, Carleton University, and Martin Head, Brock University) led the investigation of one of the twelve sites – the meromictic Crawford Lake, near Milton, Ontario, Canada. Distinct seasonal layers (varves) accumulate on the bed of this idyllic lake that occupies a small (2.4 ha), deep (~ 24 m) karstic basin weathered in carbonate rocks of the 430-million-year-old Lockport Group caprock of Niagara Escarpment. Calcite crystals formed in the upper part of the water column each summer cap organic matter that sinks to the lakebed the rest of the year, so these endogenic varves provide annual resolution across the deep basin. Sediments from individual years can thus be analysed for physical, chemical, and biological markers of Earth System conditions. Details of 8 potential GSSP ("golden spike") candidates, including the Crawford Lake succession (Figure 1) are available (open access) in a special issue of *The Anthropocene Review* published in 2023.

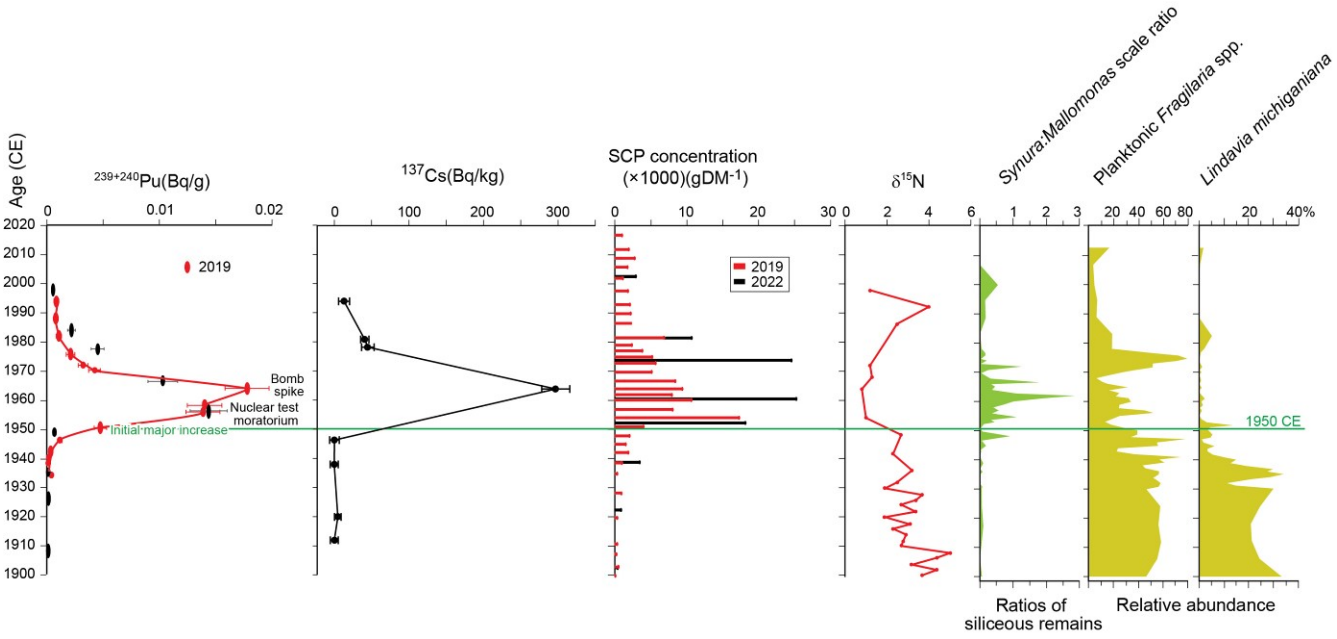

Figure 1. Summary of key markers of the Cold War ($^{239+240}$Pu and ^{137}Cs) and rapidly increased fossil fuel combustion (SCPs/fly ash and δ^{15}N) during the Great Acceleration in varve-age dated samples from Crawford Lake between 1950 and 1975 CE (data from freeze cores collected in 2019 in red and 2022 in black). Modified from McCarthy et al. (2023).

In April 2023, AWG members selected the varved sediments of the meromictic Crawford Lake as best representing the departure of conditions from Holocene norms (https://www.shh.mpg.de/2331855/pressconference).

'Team Crawford' returned to collect additional cores (Figure 2) to analyse individual varves for 'bomb radionuclides' for the proposal being submitted to the Subcommission on Quaternary Stratigraphy (SQS) early this fall, since ^{239}Pu was selected as the primary chronostratigraphic marker for the base of the proposed Anthropocene "series/epoch". Although plutonium data from freeze cores collected in 2019 and 2022 (including core CRA22-1FR-3 in which the GSSP was proposed at 15.6 cm in the varved succession; Figure 3) are a faithful record of global yields of nuclear fallout (see Figure 1), they were not performed at annual resolution due to limited sediment availability.

Irrespective of the decision of the SQS and its parent bodies, Crawford Lake and the Canadian Museum of Nature and Royal Ontario Museum where the proposed type and paratype cores are archived, respectively, are key sites to engage in discourse, debate, and evaluate the effects of humans on planetary systems, as well as the implications of the increased impact since WWII on our planet.

Reference

McCarthy, F.M., Patterson, R.T., Head, M.J., Riddick, N.L., Cumming, B.F. et al. 2023. The varved succession of Crawford Lake, Milton, Ontario, Canada as a candidate Global boundary Stratotype Section and Point for the Anthropocene series. *The Anthropocene Review* 10(1), 146–176.

Figure 2. 'Team Crawford' members Krysten Lafond (Cumming Lab, Queen's University) and Anne Nguyen (Patterson Lab, Carleton University) release a core face from the freeze corer in April 2023. Photo credit: Brock University.

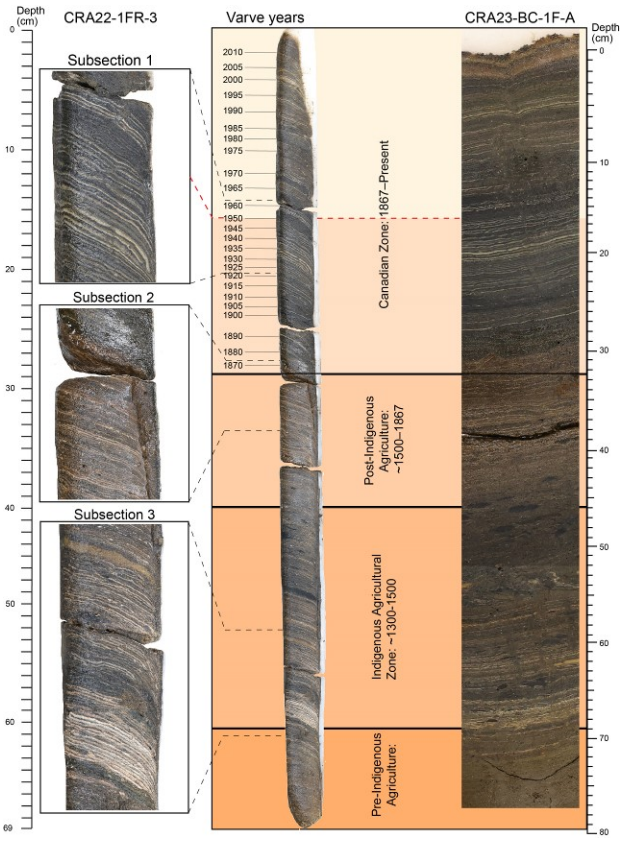

Figure 3. Distinct varves can easily be correlated between the cross section of core CRA22-1FR-3 (imaged at ultra-high resolution) and the photograph of core CRA23-BC-1F-A, one of several collected in April 2023 to achieve annual resolution analysis bomb radionuclides. Relatively thick varves characterise intervals of anthropogenic impact and cultural eutrophication (Indigenous agricultural settlement in the late 13th through 15th centuries, and colonial impact beginning in the early 19th century). Evidence of local anthropogenic impact on the lake prior to the globally synchronous tipping point in Earth Systems attributed to the Great Acceleration illustrates the concept of the stratigraphic Anthropocene resulting from the tipping point in Earth Systems during the Great Acceleration being proposed by the AWG.

7. Recent Publications

Delaney, C.A., Adamson, K.A., Linch, L.D., Davis, S., McCarron, S. 2023. Reconstructing terrestrial ice sheet retreat dynamics from hummocky topography using multiscale evidence: an example from central Ireland. *Quaternary Science Reviews* 308, 108041.

Knight, J. 2023. The last glaciers in Africa and their environmental implications. *Journal of African Earth Sciences* 200, 104863, doi:10.1016/j.jafrearsci.2023.104863.

Knight, J. 2023. Evaluating the impacts of a research ethics training course on university re-

searchers. *Social Sciences* 12, 182, doi:10.3390/socsci12030182.

Knight, J., Harrison, S. 2023. The sensitivity and evolutionary trajectory of the mountain cryosphere and implications for mountain geomorphic systems and hazards. *Land Degradation and Development* 34, 2464–2482.

Knight, J., Flack-Davison, E., Engelbrecht, S., Visagie, R., Beukes, W., Mwale, M. 2023. Compliance with the Nagoya Protocol in the Southern Africa Development Community. *South African Journal of Botany* 159, 302–318.

Plunkett, G. 2023. Environmental History of the Ballynahatty Area. In: Hartwell, B., Gormley, S., Borgan, C., Malone, C. (eds.) Ballynahatty: Excavations in a Neolithic Monumental Landscape. Oxbow, Oxford, pp. 28–30.

Wilson, P., Fabel, D. 2023. Exposure-age dating of rock avalanche debris at Raven Crag (Pasture Beckvalley, Hartsop) using cosmogenic ^{10}Be. *The Cumberland Geologist* 3, 31–35.

Yao, Y., Burningham, H., Knight, J., Griffiths, D. 2023. Monitoring of coastal boulder movements by storms and calculating volumetric parameters using the volume differential method based on point cloud Difference. *Remote Sensing* 15, 1526, doi:10.3390/rs15061526.

Quaternary Research Association

60th Anniversary Annual Discussion Meeting

4–7th January 2024

"Changing Resolutions in Quaternary Science"

The QRA Annual Discussion Meeting will take place in Manchester from Thursday 4th to Saturday 6th January 2024, with an optional field trip on Sunday 7th January 2024. This is the 60th anniversary of the founding of the Quaternary Field Studies Group, the immediate predecessor of the QRA, in 1964, and we hope to bring together researchers from all areas of Quaternary Science to celebrate this occasion.

The meeting theme, ***Changing Resolutions in Quaternary Science***, embraces contributions from **all areas of Quaternary research**. We welcome contributions relating to multiple concepts of 'changing resolutions', from advances in measurement precision, data resolution and timescales, through to a consideration of the changing practice of Quaternary research.

The ADM will take place in two Manchester universities, Manchester Metropolitan University and the University of Manchester.

Preliminary schedule

Thursday, 4th January (afternoon): AGM, keynote talk and Icebreaker reception

Friday, 5th January: Thematic sessions (talks and posters) and the QRA 60th anniversary dinner

Saturday, 6th January: Thematic sessions (talks and posters)

Sunday, 7th January: Field trip (optional) to Lindow Moss and other Cheshire sites

Further information will be available at https://sites.google.com/view/qra2024.

IQUA Membership Form

Please let your students and colleagues know about IQUA and encourage them to join. Join or renew IQUA membership online via PayPal. We encourage all our members to update their annual subscription for 2023. If you have any queries about your current IQUA membership status, or general IQUA membership queries, please contact the IQUA Treasurer Mark Coughlan (mark.coughlan@icrag-centre.org).

The annual membership cost is: €20 waged; €10 students/unwaged. IQUA offers a fast, safe, online payment system already familiar to many (PayPal) for joining IQUA or renewing your membership, and for purchasing past field guides (where available). PayPal allows you to pay securely with your credit/debit card via the IQUA website: http://www.iqua.ie/membership.html. If you do not have access to our online PayPal system, please complete the following form and send it with a cheque for the relevant annual subscription to the IQUA Treasurer Mark Coughlan at the address below. Cheques should be made payable to IQUA.

Mark Coughlan
iCRAG (Irish Centre for Research in Applied Geosciences)
O'Brien Centre for Science (East)
University College Dublin
Belfield
Dublin 4
Ireland

Name: .....

Address: .....

.....

.....

.....

Telephone: .....

E-Mail: .....

New Membership: ☐

Renewal: ☐

Total amount enclosed: .....

Thank you to our sponsors!

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

ARUP

UCD School of Archaeology