

Institution: Queen’s University Belfast

Unit of Assessment: 15

1. Unit context and structure, research and impact strategy

a. Synopsis

The long-standing integration of Archaeology with Palaeoecology (hereafter ArcPal) at QUB encapsulates the unit’s **inherently interdisciplinary** focus. Understanding past human-environment dynamics, along with world-leading initiatives in the development of dating techniques, remain prominent strengths in our wide-reaching research that investigates our past across broad temporal and spatial scales (Fig. 1). Equally, we incorporate a unique, rigorous and complementary toolset of methodologies – bioarchaeology, material science, textual evidence, geospatial and temporal analyses as well as buildings, funerary, landscape, environmental and theoretical archaeology – that positions us at the cutting edge of archaeological research and innovation. The diverse research interests and extensive networks of ArcPal staff (11.7 FTE) enable us to make **significant contributions to contemporary debates** on themes including sustainable heritage policies and management, identity and conflict management, migration, human-landscape interaction and the culture/nature divide, present and past climate impacts, and biodiversity conservation. Our achievements are exemplified by our publication record (20 books/monographs/edited volumes, 96 chapters, and >220 peer-reviewed journal articles in the REF2021 period), research income (£6.8M), growing PGR (40 graduated and current) and PDRA (18 during REF2021 period) communities, and the breadth of nationally and internationally recognised roles and accolades of individual staff, such as Reimer’s election to the Royal Irish Academy. **Engaged research** is at the heart of all our work, and we collaborate extensively with academic, public and private bodies and communities on local to global scales. Our mission is to push the boundaries in interpretation of the human and environmental past, combining the humanities and sciences to promote knowledge, cultural value and engagement with global challenges.

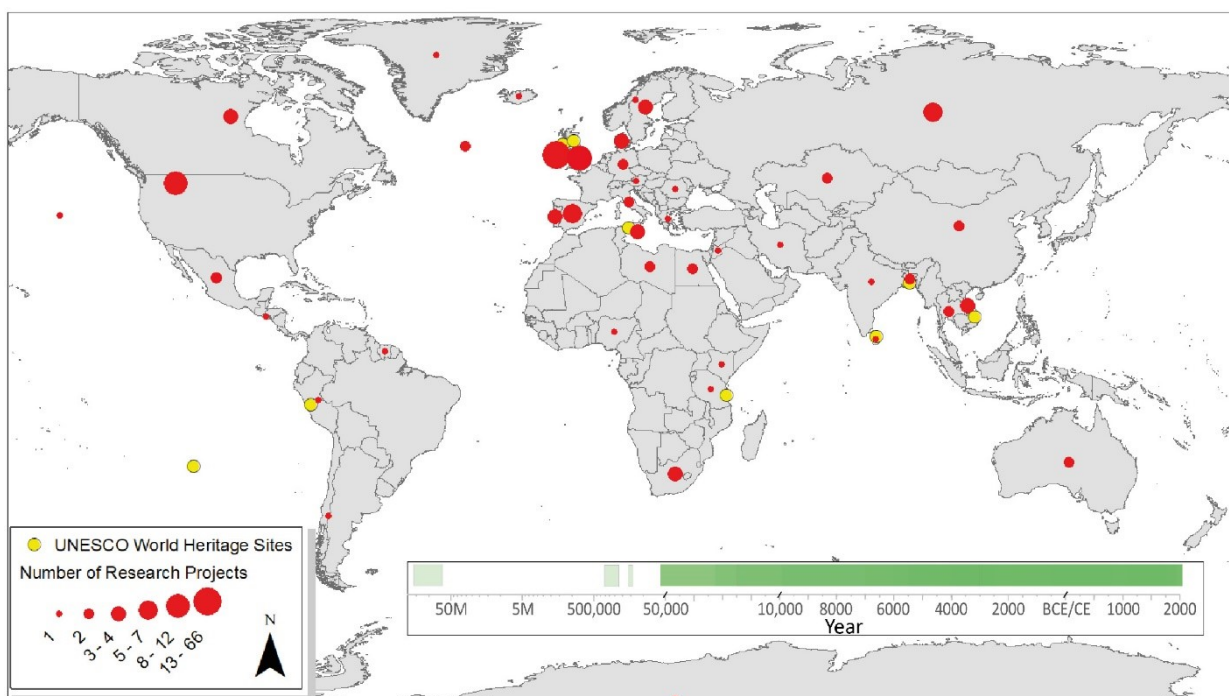


Fig. 1: The geographical and temporal coverage of ArcPal research in REF2021 period

b. Organisational structure, size and context

In REF2014, ArcPal was submitted with Geography as a single unit under UoA17. Since 2016, we joined the new School of Natural and Built Environment (SNBE), integrated with Architecture, Civil Engineering, Geography and Planning. SNBE is one of the largest in QUB (~100 academics), encompassing a diverse array of researchers with many potential synergies, facilitated by three interdisciplinary Research Clusters (RCs), two of which embrace ArcPal research interests (Fig. 2). The new School structure encourages the development of innovative collaborations between ArcPal staff and other disciplines, evidenced by our cross-disciplinary PGR supervisory panels (Section 2d).

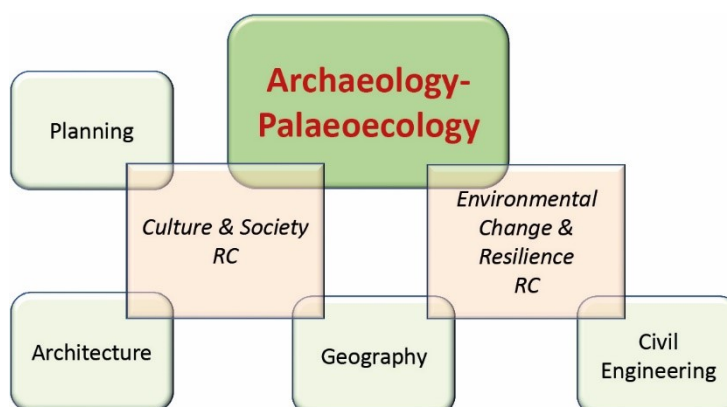


Fig. 2: ArcPal's connectivity with relevant Research Clusters (RC) and disciplines in SNBE

Presently, ArcPal comprises ten academic (8.7 FTE) and two academic-related (2 FTE) staff, eight PDRAs (including one independent researcher: 1 FTE), three emeritus professors (*Baillie, Mallory, Pilcher*) and 14 PGRs. We are supported by two centrally-funded technicians and a fixed-term Lecturer in Education (*Le Roy, 2019–2021*). With inclusion of three independent researchers in this submission (two in REF2014), the number of staff returned for ArcPal (13) remains the same as in REF2014, but our FTE is slightly lower (by 1.3 FTE) due to two transitions to part-time status. The unit hosts two research centres – **¹⁴CHRONO Centre for Climate, the Environment and Chronology** (¹⁴CHRONO) and the **Centre for Community Archaeology** (CCA) – that support teaching, research and community projects (Section 3b), and *Megarry* is Associate Director of Geography's **Centre for GIS and Geomatics**. ArcPal members are active within QUB's *Senator George Mitchell Institute for Global Peace, Security and Justice*, the *Heritage Hub* and the *Centre for Sustainability, Equality and Climate Action*, and most staff affiliate with the *Institute of Irish Studies*.

The RCs aim to create a culture of research excellence through active promotion of collaboration, impact, engaged research, public outreach, support and mentoring of ECRs, and alignment of School and disciplinary research with the institutional research strategy. They offer seed funding and financial support towards, for example, conference attendance, international networking, hosting of public events and analytical costs.

- The **Culture and Society** RC (C&S) comprises staff from ArcPal, Architecture, Geography and Planning who share interests in exploring past and present relationships between peoples, cultures and societies at various spatial and temporal scales. Of relevance to the global challenges and academic discourses addressed by C&S is ArcPal's collaborative and impactful research on climate change, sustainability and cultural heritage, specifically archaeological heritage (reflected by *Malone, Rabett* and *Megarry's* Impact Case Study (ICS)); understanding societal change, past migrations and their impacts (see publications of *Brandherm, Donnelly, Gleeson, Malone, Murphy*, and projects such as ERC-funded FRAGSUS and AHRC-funded *Sea of Moyle*); bioarchaeological approaches to past populations (in *Murphy's* publications and *Ranelagh* project); and the social benefits of

community archaeology (reflected in publications by *Donnelly, Horning, Murphy*). C&S facilitated the development of an interdisciplinary project between *Megarry* and colleagues in Geography, Architecture and Anthropology, helping secure funding for the “Adaptation, Cultural Heritage and Ongoing Resilience for Sustainable Livelihood” (ANCHOR) Project. It has also provided seed funding for various projects, including fieldwork grants to investigate Neolithic Shetland (*Megarry*), an Anglo-Saxon Royal Palace at Milfield overlain by World War I field remains (*Gleeson*), and new research on the Ulster Museum’s Egyptian mummy Takabuti (*Murphy*).

- The **Environmental Change and Resilience** RC (EC&R) includes staff from ArcPal, Geography and Civil Engineering with common goals of understanding and tackling the impacts of environmental change through, for example, geospatial analysis and spatial-temporal modelling. Within this group, ArcPal staff lead and contribute to subgroups on *Landscape & Climate Change Resilience*, and *Peatlands, Hydrogeology & Wetlands*. ArcPal staff bring to these themes a long-term view of past environmental changes and their impact on ecosystems and societies, including chronology construction (evidenced by publications by *Blaauw, Brown, Plunkett, Reimer*, and the ICS by *Reimer and Blaauw*); causes and impacts of past environmental change (including publications by *Blaauw, Plunkett, Rabett, Reimer*); and human-environment interactions (considered in outputs by *Murphy, Plunkett, Rabett*, formerly *Basell, McCormick*, and through projects such as *SUNDASIA* and *FRAGSUS*). EC&R played an instrumental role in the 2019 establishment of the £5M NERC-funded QUADRAT (co-led by *Blaauw*) doctoral training programme (DTP), which trains next-generation scientists to be leaders in academic, industry and policy development through interdisciplinary and engaged research in collaboration with University of Aberdeen (UAb), QUB’s Biological Sciences and a network of non-academic partners.

c. Research and impact strategy

Our strategic research agenda has developed over the REF2021 period, reflecting School restructuring in 2016, staff changes, and opportunities to pursue productive new research directions. Our new strategy is informed by key research questions and debates in, and between, SNBE disciplines and RCs, QUB’s strategic themes and investment, and UKRI strategies and priorities. The strategic aims outlined in ArcPal-Geography’s REF2014 submission are presented in Table 1 with examples of how we realised those aims. Impact is a consistent feature of our research, exemplified by the array of projects encompassed within our two ICSs. Our achievements speak to institutional priorities through the REF2021 period (research ambition, tackling of global challenges, and creation of a vibrant PGR and PDRA community), while embracing the cross-cutting themes of internationalisation, impact and environment (Institutional Environment Statement (IES), Section 2b).

Table 1. ArcPal delivery on REF2014 strategic aims

REF2014 strategic aims	Highlights of ArcPal achievements in REF2021 period
<i>Lead and contribute measurably to global scientific [and critical human geography] enquiry</i>	<ul style="list-style-type: none"> • Through their ERC-funded (£1.2M to QUB) <i>FRAGSUS</i> and AHRC/industry-funded (£933k to QUB) <i>SUNDASIA</i> projects, <i>Malone</i> and <i>Rabett</i> have respectively tackled questions of past societal adaptation to environmental change. Two (of three) monographs detailing the <i>FRAGSUS</i> findings have been published, and the ongoing <i>SUNDASIA</i> project has so far resulted in five peer-reviewed outputs. • <i>Murphy’s</i> and <i>Svyatko’s</i> interdisciplinary research on Irish and Russian human remains have contributed to discourses on past diet, health and migration (e.g., <i>Murphy’s</i> papers in <i>Nature</i>, <i>PNAS</i>; <i>Svyatko’s</i> article in <i>J. Archaeo. Sci. Rep.</i>). <i>Murphy’s</i> analyses of large Medieval cemetery assemblages (including Irish Government-funded (£432k) <i>Ranelagh</i> project) shed new light on life among

	<p>Ireland's lower non-elites, and have so far resulted in two monographs. Svyatko's Leverhulme-funded (£210k) investigation of prehistoric populations examines the emergence of nomadism in the Altai Steppes.</p> <ul style="list-style-type: none"> • <i>Blaauw, Brown, Plunkett, Rabett and Reimer</i> have produced >30 high-profile publications on past climate change, its causes and its environmental and societal impacts on regional to global scales (e.g., <i>Nature, Nature Ecol. Evol., Nature Sci. Rep., Geology</i>). The NERC-funded (£80k to QUB) <i>Reimagination</i> project (<i>Reimer, Blaauw</i>) considered the extent of past North Atlantic overturning, an important component of the Earth's climate system. The Leverhulme-funded (£65k to QUB) <i>Limfjord</i> project investigated environmental change and subsistence strategies in Denmark over the past 4,000 years (<i>Reimer – Nature Commun.</i>).
<p><i>Influence contemporary debates (from climate change to conflict resolution, the management of memory, the geographies of science, geopolitics, globalisation, population dynamics and public policy)</i></p>	<ul style="list-style-type: none"> • <i>Horning's</i> treatise (<i>Archaeologies</i> and others) on archaeology, identity and conflict in Northern Ireland sets out the difficulties surrounding the position of archaeology in community projects, and illustrates how archaeological discourse can be purposefully applied to reconciliation and peace-building in divided societies. • <i>Gleeson's</i> award-winning <i>Medieval Archaeology</i> paper challenges an existing paradigm that attempts to find historical bases for myth in the archaeological record, and calls for greater recognition of underlying socio-political agendas within early literary sources. • <i>Plunkett's</i> tephra research has contributed to the refinement of Greenland ice-core chronologies, enabling precise chronological linkages between volcanic events, tree-ring data and historical events, and questioning conventional thinking on volcanic forcing of climate and its impacts (e.g., <i>Nature, PNAS</i>).
<p><i>Develop, employ and disseminate new techniques of data analysis</i></p>	<ul style="list-style-type: none"> • <i>Megarry</i> has developed and refined predictive site modelling using machine learning and automated characterisation of multispectral satellite imagery as applied to remote identification of archaeological sites in marginal landscapes and over wide areas (e.g., <i>Drones</i>). • Staff have published >60 outputs and open-source software demonstrating an extensive contribution to advances in chronology construction, analysis, modelling, refinement and interpretation, e.g., <i>Reimer's</i> international radiocarbon calibration curves (<i>Radiocarbon</i>); <i>Blaauw's</i> innovative Bayesian approach to 210Pb age-modelling (<i>J. Agric. Biol. Environ. Stat.</i>); PDR <i>Barrett</i> and <i>Donnelly's</i> development of a new technique for dating mortar (<i>J. Archaeol. Sci. Rep.</i>). • Meta-analyses of archaeological, palaeoenvironmental and tephra data have challenged paradigms of environmental explanations of cultural change (<i>Blaauw, Plunkett – Geology</i>), provided a geochronologically-modelled Neotropical pollen database (<i>Blaauw – Clim. Past</i>), and enabled the first evaluation of tephra source regions impacting NW Europe (<i>Plunkett – Earth Sci. Rev.</i>)
<p><i>Inform and influence heritage management practices and public engagement with the past</i></p>	<ul style="list-style-type: none"> • <i>Megarry</i> has developed the Google Arts and Culture-funded Heritage on the Edge online resource with ICOMOS, highlighting the urgency about climate change through the lens of five iconic world heritage sites. • <i>Malone, Rabett</i> and <i>Megarry's</i> work on 10 World Heritage and other protected sites have shaped best practice regarding the management and presentation of cultural and natural heritage, including public engagement with the past (see their <i>ICS</i>). • <i>Donnelly, Horning, Malone, Megarry, Murphy, Rabett</i> have developed public partnerships and projects on local to global

	<p>scales, e.g., the CCA's six Landscape Partnerships (£685k) entailing 20 community excavations; Horning's work with the Corrymeela Community, including the 2018 <i>Winter School in Heritage and Reconciliation</i>.</p>
<p><i>Develop collaborative international research agendas</i></p>	<ul style="list-style-type: none"> • <i>Rabett</i>, supported by a UKRI-GCRF Global Impact Acceleration Award (£11.9k), has co-led the trial reintroduction initiative of a critically endangered primate species into Trảng An working in collaboration with local Vietnamese authorities, industry and NGOs. • <i>Gleeson</i> has contributed to international discourse on the role of assembly places in the Atlantic fringe, presenting a new chronological framework for the role and development of the <i>Óenaig</i> in Ireland (e.g., <i>J. North Atlantic</i>). • As president of the International Union of Prehistoric and Protohistoric Sciences Commission 'Metal Ages in Europe', <i>Brandherm</i> coordinates the development of collaborative research agendas in European Bronze Age and Iron Age archaeology, e.g., concerning networks of knowledge transfer in the Early Iron Age Mediterranean.
<p><i>Inspire & facilitate new researchers through a proactive strategy of attracting and supporting high-quality PGRs and embedding ECRs into our grant-funded projects</i></p>	<ul style="list-style-type: none"> • We have recruited three academic ECRs (<i>Rabett, Megarry, Gleeson</i>), all now promoted to senior grades (Section 2c). • We have newly employed 15 PDRAs through ¹⁴CHRONO (2), the <i>Crannogs</i> (1), <i>FRAGSUS</i> (5) and <i>SUNDASIA</i> (3) projects, or as independent researchers (4; Section 2d). • Through UKRI-funded DTPs and NI-Department for the Economy (DfE) collaborative partnerships, we have recruited 16 PGRs, including interdisciplinary collaborations (entailing joint supervision) with Architecture, Planning, Geography, Politics, Mechanical and Aerospace Engineering (Section 2e).

Considering staff changes, new interdisciplinary opportunities and the growing urgency of global challenges, we have honed our research strategy and developed a plan for the next 5–10 years. Building upon the expertise and diversity of infrastructural facilities at QUB, our long-term goal is to enhance and expand our strengths and expertise in scientific, community and digital archaeology, isotopic research for archaeology (migration, diet, etc.), and palaeoenvironment and chronological research. We identify five key aims that encapsulate the unit's strategic research plan, underpinned by key UKRI and institutional research priority themes (Fig. 3).

- 1) Extend capacity to engage in **world-leading interdisciplinary research to address global challenges**, such as identity and conflict, migration, heritage conservation, environmental degradation and climate change through innovative collaborations across the School and wider University, with our national and international academic and non-academic partners, and by expanding our PGR and PDRA community
- 2) Develop further our digital capabilities to ensure we remain at the forefront of **applications in geospatial technologies, chronology-building, virtual reality and digital methods** of presenting past peoples, objects and landscapes, and in their utility to heritage management and communication
- 3) Strengthen and grow the CCA and ¹⁴CHRONO as **hubs for high-impact research** that engage stakeholders and beneficiaries at local, national and international levels
- 4) Consolidate and expand our existing reputation for **engaged research** through Community Archaeology and partnerships by applying for major funding in areas such as identity, well-being, shared education, peace-building and sustainable heritage, including through collaborative studentships with partners outside academia
- 5) Utilise the considerable skillsets of staff within ArcPal and the wider School to promote **heritage as a driver for sustainability and resilience globally**, though capacity training and knowledge exchange, especially in the Global South and in line with UN sustainability goals

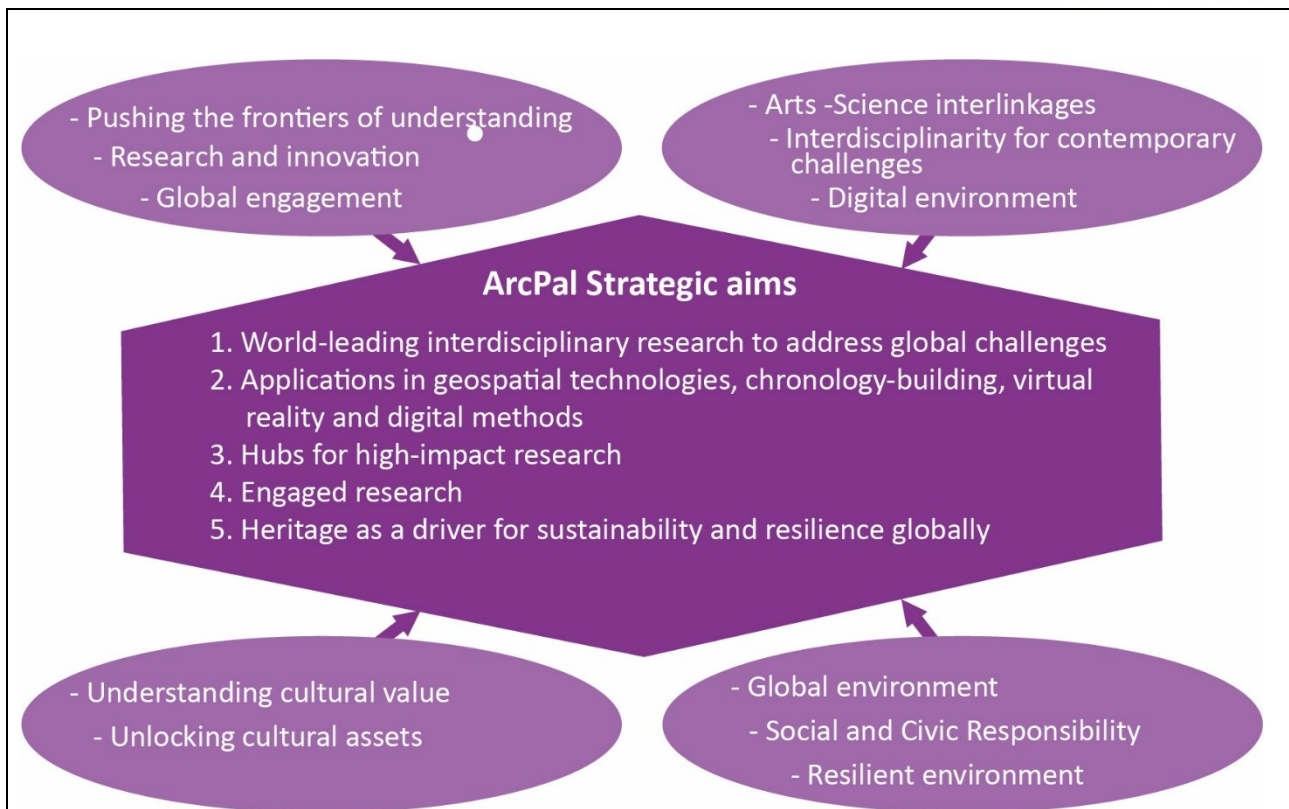


Fig. 3: ArcPal’s strategic aims and unpinning School, institutional and UKRI priority themes

d. Interdisciplinary Research

The long-standing interdisciplinarity of our research, reflected by the integration of palaeoecological methodologies to address archaeological questions (e.g., *FRAGSUS*, *SUNDASIA*, *Sea of Moyle*), and cultural contextualisation of climate/environmental impacts (e.g., volcanic impacts, marine resource abundance) through archaeological and historical enquiry (e.g., *Reimer’s*, *Plunkett’s* outputs). For instance, the combination of archaeological investigation and integrated palaeoenvironmental analyses in *FRAGSUS* was critical for determining how Malta’s Neolithic inhabitants adapted to climate change and soil erosion. SNBE’s new structures have broadened our interdisciplinary research culture, specifically through the RCs. Examples of fruitful partnerships include *Megarry’s* ANCHOR Project (Section 1b); the formulation of five cross-discipline PGR projects; *Gleeson’s* establishment of a cross-Faculty research *Medieval Cultures* seminar series; and the cross-Faculty *Heritage Hub* (C&S). We benefit from wider University structures for interdisciplinary research (IES Section 2c), including links to the Global Research Institutes (Section 1b).

Our interdisciplinary research networks within and beyond QUB allows us to tackle pressing societal challenges. *Malone, Rabett and Megarry’s* ICS illustrates our contributions to conservation and integrating heritage into policy-backed climate action. *Murphy’s* work examines historical links between health, diet and environment, including the use of aDNA to understand better the history of communicable diseases, while the CCA’s ongoing community projects address issues of well-being and identity. *Horning’s* work illustrates the importance of empirical-based use of the archaeological record as a tool in conflict resolution. *Blaauw, Plunkett and Reimer* work with researchers in archaeology, history, earth and atmospheric sciences, and statistics to establish drivers and impacts of past environmental changes, including implications for past societies (e.g., *Blaauw’s* DeepCHALLA-UK project, *Plunkett’s* PNAS papers critically examining volcanic impacts on contemporary societies in Europe and Central America, *Reimer’s* Leverhulme project on climatic controls on human adaptation in Denmark). Effective collaboration has been further facilitated by interdisciplinary DTPs (Northern Bridge, QUADRAT).

e. Open Research

We strive to ensure our research reaches as wide an audience as possible. We make available large datasets through publication (e.g., *Plunkett's* tephra results as supplementary data), open repositories (e.g., European Pollen Database, International Tree Ring Database) and open-source media (e.g., age-modelling software Plum, Bacon, Clam, CALIB, IntCal). We make full use of wider university arrangements for open research, including the QUB data repository. All Centre for Archaeological Fieldwork (CAF)/CCA fieldwork reports are available to download from the [CCA website](#). The SUNDASIA project publishes annual reports locally (the last two in *Vietnam Archaeology*) to support in-house journals and local access. Reflecting our strong commitment towards open access (OA), 80% (n=176) of our journal articles and conference papers during the REF2021 period were available via OA display; since the HEFCE Policy on OA was introduced (April 2016), that proportion increased to 89%.

f. Research integrity and ethics

Our approach to research governance, integrity and ethics has been extensively restructured over the REF2021 period. Building on the UK Concordat for Research Integrity we have developed a culture that nurtures an understanding of ethical implications of research, which have involved specific training programmes on Ethics, GDPR, IP and Diversity for postgraduate researchers and staff. QUB has established a Research Governance and Integrity Committee, with School-level representation, that ensures a more integrated approach between ethics, standards of conduct, support for doctoral students and ECRs and stronger mechanisms for complaints and redress. The Faculty Research Ethics Committee is represented by an individual from the School. Our ethical conduct is increasingly informed by the challenges and benefits of more inclusive engaged archaeology, in line with changing global practice that emphasises the rights of descendant populations. All staff and PGRs working with human remains adhere to the guidelines of the British Association of Biological Anthropology and Osteoarchaeology Codes of Ethics and Practice (2019).

2. People**a. Summary overview of approach**

ArcPal comprises a small but cohesive research group underpinned by a strong sense of connectivity and collegiality between academics, ECRs, PGRs and support staff. Retirements and staff turnover since 2014 provided opportunities to make strategic appointments to develop our strengths in line with our research priorities, most notably in terms of augmenting our contributions to heritage management and geospatial enquiries. Equally, we have recruited PDRAs (n=2) and technical support (n=1) to consolidate and expand the reach and impact of our two hosted centres, and have provided career and professional development opportunities for PDRAs through recruitment to collaborative and independent research projects. We have maintained a strong PGR base through diverse studentship opportunities. Within the broader context of the collaborative and interdisciplinary School structure, these changes leave us well-placed to deliver on our research strategy.

b. Staffing profile and recruitment

ArcPal staffing has changed since REF2014 due to one staff member retiring and three taking positions in other institutions. Two staff have moved to part-time status (reflecting flexi-retirement and an appointment at a US institution). Our FTE includes three independent researchers (*Brown, Donnelly, Svyatko*) in line with REF2021 policy on including all staff with significant research responsibility. The rapid career progression of our academics (Section 2c) gives us a robust framework of mid-career and established researchers, complemented by two permanent academic-related staff (*Brown, Donnelly*) and a total of 18 PDRAs on fixed-term contracts or fellowships during the REF2021 period. The CCA employs five field archaeologists on fixed-term contracts, and the unit's research-driven ethos is reflected by members undertaking doctoral studies within ArcPal: in the REF2021 period, one completed a part-time PhD, while two have

transitioned to our full-time PGR programme having obtained competitive funding. ¹⁴CHRONO employs two PDRAs, a research assistant and five technicians. Staff and PGRs are supported by a part-time illustrator.

Three strategic new permanent appointments have been made during the REF2021 period, specifically to deliver the unit's goals.

- 1) Lecturer in Human Palaeoecology (Rabett), enhancing links between archaeology and palaeoecology and bringing new expertise in SE Asian prehistory and experience in world heritage site inscription
- 2) Lecturer in GIS (Megarry), bringing expertise in geospatial analysis and heritage management
- 3) Lecturer in Early Medieval Archaeology (*Gleeson*), complementing existing specialisms in this era, and expanding our approaches to landscape visualisation

All three staff have been confirmed in post and promoted to Senior Lecturer. Additionally, the School appointed an ArcPal-based GIS technician (*McDermott*) to support the CCA and staff. Forward planning for the phased retirement of *Reimer* (beginning autumn 2020) includes the appointment of *Blaauw* as Deputy Director of ¹⁴CHRONO. Further recruitments in ArcPal during the REF2021 period include two Lecturers in Education (*Shuttleworth* 2017-19; *Le Roy* 2017-18, 2019-21) to enable *Malone* and *Rabett* to focus on research.

ArcPal's strategic running is overseen by the *Head of Discipline* (HoD; *Murphy*), who participates in regular School management meetings with the *Head of School* (HoS), other HoDs, and *Directors of Research* (DRs) and *Education*, representing the interests of the unit. The *School Research Committee*, led by HoS, includes the DRs, the School's *Director for Postgraduate Research*, and the *School Impact Champion* whose role entails promotion of engaged research with a wide spectrum of non-academic stakeholders and beneficiaries, in line with QUB strategy, and elected representatives of the PDRA community.

c. Staff development and career progression

Through shared workspaces, research seminars and frequent social interaction, ArcPal offers an intellectually stimulating and inclusive research environment for all staff, ECRs and PGRs. Staff development is supported by QUB's Staff Training and Development Unit, and the Research and Enterprise Directorate (R&E), which offers one-to-one guidance and feedback on research and impact activities. QUB operates a series of leadership development programmes aimed at various career stages and categories of staff.

Newly appointed staff undertake a **probationary period** (usually three years) to acclimatise to QUB practices and environment, during which time they have reduced teaching and administrative loads to enable them to consolidate their research portfolio. Line-managers of probationers adopt a mentoring role, and through Queen's Gender Initiative, all female staff are offered mentoring from outside the School. All academic ECRs must complete training on *Supervising Research Students* and obtain Fellowship of the HEA as a requirement to pass probation. Early confirmation in post can occur where staff demonstrate they have met the requirements of the probationary period, and two staff have benefitted from accelerated advancement (*Rabett*, *Gleeson*).

ArcPal has noticeably profited from a change in culture within QUB, with the release in 2018 of its *People First* policy (IES Section 3a). Progression is now actively promoted at unit, School, Faculty and Institutional levels through mentoring opportunities and workshops. The staff appraisal system has been replaced by a more development-focused framework, the **Personal Development Review**, which is an ongoing process encouraging staff to reflect on their personal and professional ambitions, in alignment with QUB's priorities and core values. All staff with line-management duties undertake mandatory training before they engage in reviews. For ArcPal, line-management of academic staff is usually via the HoD, while that of academic-related staff is through HoD, Principal Investigators (for PDRAs on research projects) or Centre Directors (¹⁴CHRONO, CCA). During the REF2021 period, **eight staff were promoted** (six since

2018-19): four to Senior Lectureship (three males, and one female, now moved to another institution), three to Reader (one female, two male), and two to Professor (both female).

In keeping with QUB policies, the School uses a **Work Allocation Model** (WAM) to help staff balance their responsibilities. For academic staff, the WAM encourages the development of research proposals with a time allocation for leading and collaborating on funding bids, whilst monitoring time spent on funded research, PGR and PDRA supervision, teaching and administration. In addition to encouraged externally-funded research leave, the School operates a system of **sabbatical leave** for all non-probationary academic staff, awarded after either three or six years of full-time research/teaching, subject to a suitable research plan being approved by School Management. Sabbatical leave is managed through careful forward-planning and collegiality. During the REF2021 period, five members of staff (three female, two male) had sabbatical leave, enabling completion of research projects and major publications (e.g., *Murphy's* second Ballyhanna monograph).

d. ECRs

We are committed to supporting ECRs in their development of a sustainable career path. Since 2014, our newly appointed ECRs have included three academics and 15 PDRAs affiliated with ¹⁴CHRONO (3), CCA (1), collaborative research projects (Crannogs: 1; FRAGSUS: 5; SUNDASIA: 3), or on individual fellowships supported by Leverhulme (*Svyatko*), the British Academy (*Thomas*), Marie Skłodowska-Curie Action (MSCA; *Boutoille*) or Newton International Fellowship (NIF: *Sun*). In addition to mentoring opportunities and a research-focused workload (Section 2c), ECRs benefit from a dedicated RC budget that supports hosting and attending networking events, organising upskilling and training events, and proof of concept development, as well as an informal peer review system to guide their development of grant proposals. Six ECRs (*Megarry*, former staff *Basell*, and three PDRAs) have benefited from ring-fenced support (total: £3.9k). In addition, the School promotes the progression of early-career academics through the prioritisation of DfE studentships towards projects led by those staff, with one secured by *Gleeson*.

SNBE runs a mentoring programme for PDRAs to support skills such as proposal writing, time-management and employability. PDRAs are encouraged to undertake at least 10 day's training annually to develop their research and leadership skills, in line with the Researcher Development Framework, the Concordat to support the Career Development of Researchers and the European Charter for Researchers. Where contracts permit, PDRAs are offered opportunities to contribute to or lead teaching activities to enhance their employability for academic roles (*Thomas*, for example, designed and delivered an undergraduate module). Three PDRAs have since secured positions in academia or research-related environments (*Thomas*, *Farrell*, *McLaughlin*), and *Sun* will be appointed to a permanent position in the Chinese Academy of Sciences on completion of his Fellowship.

e. PGRs

ArcPal recognises the importance of PGRs for a healthy and robust research environment, and all staff are involved in their supervision.

- **Vibrant PGR community.** Since REF2014, 26 PGRs have graduated in ArcPal, an increase of five compared to ArcPal-related completions in REF2014. At the census date, we were engaged in supervision of 14 PGRs, and co-supervision of four PGRs in other disciplines and four in other institutions. Despite curtailment of local Government-funded studentships since 2017, ArcPal maintains a strong PGR recruitment profile through competition for studentships from AHRC-funded Northern Bridge (NB) and, since 2018, NERC-funded QUADRAT DTPs, resulting in the total recruitment of 12 PGRs (including autumn 2020 starts). Additionally, staff have recruited PGRs through a DfE-funded studentship (*Gleeson*), a DfE-QUB collaborative partnership with the National Museum of Northern Ireland (*Megarry*) and the Horizon 2020 Marie-Curie COFUND SPaRK project (*Murphy*).

Training and management. PGR students undertake 30+ days training during their programme, including events run by QUB's Graduate School, or opportunities (e.g., courses in R, age-model development) within the School or externally. Progress is monitored through regular supervisory meetings and a series of formal milestones overseen by an Annual Progress Review Panel comprising two staff not involved with the student's research (Fig. 4). Students approaching their *Viva Voce* are offered a mock examination. DTP- and DfE Collaborative project-funded PGRs benefit from placement opportunities in professional settings (e.g., Heritage Council (Ireland), Pigorini National Museum of Prehistory and Ethnography). PGR administration is handled by SNBE's *Director of Postgraduate Research*, who chairs the School's Postgraduate Research Committee (SPRC). PGR student representatives sit on the Student Voice Committee, the SPRC, and the School's Research Committee.



Fig. 4: PGR management and progress monitoring

- Research environment and employability.** PGRs affiliate with one or more of the RCs, and attend Cluster meetings and surgeries. The RCs offer funds that ensure self-funded students have access to research support (e.g., for fieldwork, research expenses), made available on application to the RC (all applications to date have been approved: total £4.9k). Students whose research involves isotopic or ^{14}C analysis are trained by ^{14}C CHRONO staff, and analytical charges are minimal or waived. ArcPal PGRs run their own seminar series and an in-house training programme (facilitated by staff) to complement training provided by the Graduate School and the DTPs. Staff encourage students to publish aspects of their research during the course of the PhD to improve their employability and competitiveness on completion of their studies. Recent PGRs demonstrate an excellent publication record (collectively, 15 have 55 peer-reviewed outputs from their PhD research), and half of the current PhD cohort has published at least one paper relating to their projects. Of the 26 PGRs graduated since REF2014, 10 have taken up research posts (e.g., Aarhus University, University of Malta), and six are professionally employed (e.g., Director of Mattapoissett Museum, Massachusetts; Assistant Curator at Historical Royal Palaces). Two were awarded prizes for their dissertations (*Logue* – the Society for Historical Archaeology PhD Dissertation Award in 2019; *Loyer* – the Prize of the Société d'Anthropologie de Paris in 2020).

Final-year PGRs in 2020 were given a three-month no-fees extension to their programme to compensate for the period of campus closure resulting from COVID19 restrictions. Supervision and progress monitoring were conducted remotely.

f. Equality and diversity

We strive for equality in all our activities, exemplified by a strong gender balance in our staffing and ECR populations (Fig. 5). Through our active participation in the School Athena SWAN SAT, there is a strong commitment to improve diversity beyond the focus on gender to one more attentive to BIPOC and LGBTQ. At the census date, there were eight full-time academic staff comprising (female: male) five senior lecturers (0:5), one reader (1:0) and two professors (2:0); three academics were further promoted in Spring 2020 (effective from 01/08/20). Additionally, there are two part-time (0.2 and 0.5 FTE) female professors. Our FTE includes a multinational staff (NI: 3, Republic of Ireland: 3; GB: 2; Netherlands: 1; Germany: 1; USA: 2; Russia: 1), and the wider community includes PDRAs and PGRs from China, EU, GB, NI and USA. The most

recent full-time academic appointment was in 2017 (Gleeson, male). We have a predominantly white ethnic profile, reflecting challenges of recruiting non-white staff and PGRs in this field in NI (white population 98% vs UK-wide 86%). We strive for gender equality when formulating our seminar series (in the REF2021 period, 43% of our invited speakers were female), in representation in PGR *Viva Voce* examinations, and in recruitment of external examiners.

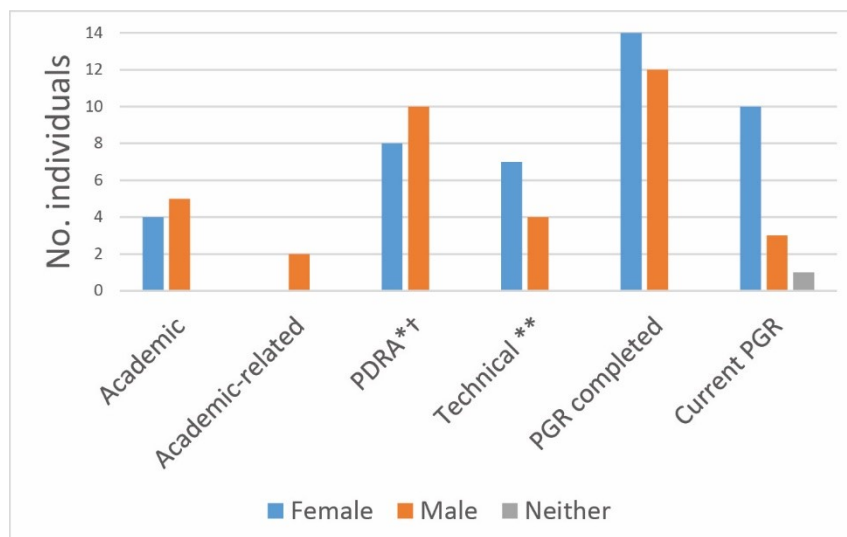


Fig. 5: Gender balance in ArcPal (*all PDRAs in REF2021 period, including NIF; †data inferred from assigned gender; **includes ¹⁴CHRONO and CCA staff)

As part of the former School of Geography, Archaeology and Palaeoecology (GAP), ArcPal held an Athena Swan Silver Award (2010–18). SNBE has made positive steps to promote equality and improve staff wellbeing, including adopting practices initiated by GAP (e.g., striving for gender equity in invited speakers; ensuring male and female representation in PhD examinations, School Committees, and outreach and recruitment events; open competition for internal positions of responsibility; reduced workload for women returning from maternity leave), and the outcome of an application for a Bronze Award is pending.

During the REF2021 period, one academic (subsequently promoted) took funded maternity leave and another, paternity leave. QUB provided cover for a replacement lecturer for the female academic, ensuring she could avail fully of her leave with minimal disruption to the unit, and providing an ECR with valuable experience. In addition, two PDRAs and one PGR availed of funded parental leave.

3. Income, infrastructure and facilities

a. Overview of research grants/income and strategies for funding

In working towards our strategic goals, our research income over the REF2021 period has exceeded £6.8M (mean spend/FTE: £582k), a 58% increase on ArcPal income (£3.9M) in REF2014. All academic staff have been PI on at least one project, and have individually been awarded no less than £27k (78% >£100k, 22% >£1m). Our funding sources have diversified considerably, with a shift from mainly (55%) local government funding in REF2014 to a more competitive base including UKRI/British Academy/Royal Society (21%, up from 8% in REF2014) and EU Government (24%, up from 16%) (Fig. 6). Local government funding remains an important income stream, but has moved from almost exclusively central government (Dept. Environment/NI Environment Agency) to a much wider spectrum of public authorities, reflecting our increased focus on engaged research and bridge-building activities through the work of the CCA. All-Ireland collaborations continue to generate research funding (e.g., *Murphy's* Irish Government-funded *Ranelagh Osteological Project*, £432k), and we were successful in securing

EU funds through ERC and MSCA. PDRA individual fellowships were supported by Leverhulme, British Academy, MSCA and NIF.

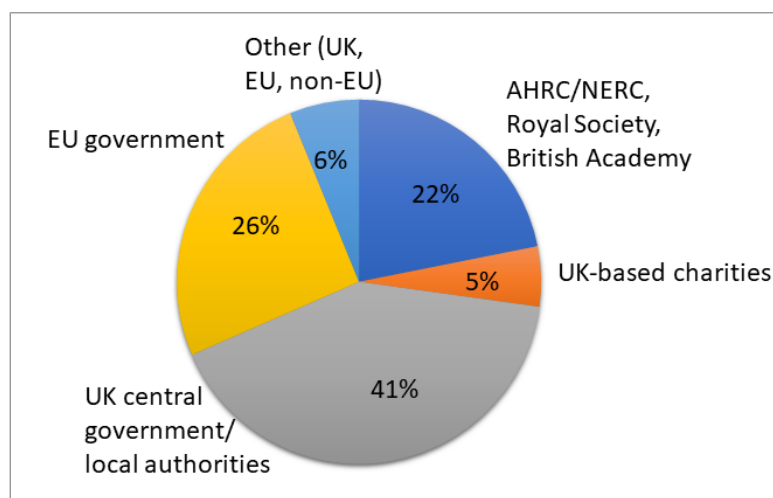


Fig. 6: Summary of ArcPal income sources

Notable achievements driven by our strategic priorities showcase the reach of our research.

- The interdisciplinary ERC-funded (£1.2m to QUB) *FRAGSUS* project (*Malone*) and ongoing AHRC/industry-funded (£933k to QUB) *SUNDASIA* project (*Rabett*) examine human adaptation to environmental change, each representing international collaborations with non-academic partners, with a strong emphasis on the promotion and protection of heritage, public engagement, and informing policy (Section 4c).
- The CCA has been proactive in six Heritage Lottery Fund/National Lottery Heritage Fund landscape partnerships (totalling £685k in awards) and has established a range of public partners including local councils, PEACE IV projects, the Historic Environment Division of Department for Communities, local museums, and the Royal Irish Academy (Section 4c).
- Migration and adaptation are common themes, explored in different ways, in both the ongoing Leverhulme-funded *Altai* (£210k; *Svyatko*) and AHRC-funded *Sea of Moyle* (£79k; *Gleeson, Plunkett*) projects.

Research funding is now a firmly embedded part of the School culture (Section 3b). The RCs and R&E actively promote and facilitate discussions about competitive bids, and facilitate peer-review of applications. R&E and Faculty communicate new funding opportunities through monthly bulletins.

In addition to seeking funding to deliver our strategic aims, we identify a number of key priorities.

1. We will work to ensure all staff become leaders in impactful research by sharing good practice, mentoring less experienced staff and including them as co-investigators on collaborative project development.
2. We will aim for greater attention to impact pathways and knowledge transfer within research publications to highlight the value of Archaeology and Palaeoecology and advance integration into policy.
3. We will pursue UKRI infrastructural funding to ensure our facilities remain cutting-edge, expand our capacity for understanding the past through innovative technology and interdisciplinary collaboration, and continue to offer analytical facilities otherwise inaccessible to the wider heritage sector on the island of Ireland. **In Spring 2020, QUB committed to funding a replacement of the current AMS with a new state-of-the-art £2.1M MiCADAS which will be operational by mid-2021.**
4. We will aim to promote a culture of diversity and inclusion by attracting PDRAs through international collaborative and independent research fellowships.

b. Organisational infrastructure and support for research and impact

ArcPal hosts two self-funding research centres that are central to the unit's identity and strategic priorities. We also work closely with Geography's *Centre for GIS and Geomatics* that hosts a diverse collection of spatial data resources via web-based mapping portals.

- The **Centre for Community Archaeology (CCA)**, co-directed by *Donnelly* and *Murphy*, has evolved from the Centre for Archaeological Fieldwork (CAF) which undertook >130 large-scale excavations since 2002. With a change of emphasis towards community-based research projects, the CCA was established in 2017 and the unit has conducted 20 community-based archaeological excavations. It works closely with the Belfast Young Archaeologists' Club (YAC; established 2006, *Murphy, Brandherm*) and the Ulster Archaeological Society, whose membership largely comprises retired individuals. As such, our community-based work spans young children through to the elderly, thereby raising public awareness of local heritage to all age groups.
- The **¹⁴CHRONO Centre for Climate, the Environment and Chronology**, led by *Reimer* and *Blaauw*, has a world-renowned reputation for its contribution to chronology construction, and is one of only four centres in the UK to provide ¹⁴C-dating. In addition to its AMS facility, ¹⁴CHRONO is equipped to run stable isotopes (carbon and nitrogen, and in collaboration with SNBE's *Stable Isotope Facility*, sulphur, hydrogen and oxygen). ¹⁴CHRONO generates considerable trade income through services to commercial archaeology, heritage institutions and through affiliated internal and external research projects, and also attracts an extensive range of international collaborators, leading to high-impact research (see *Reimer* and *Blaauw*'s ICS). SNBE PGRs and staff benefit from reduced (or waived) costs. Additionally, the Dendrochronology Laboratory generates income from commercial dating of oak timbers, primarily from archaeological or historical contexts, and offers consultations to professionals working with historic buildings. Data from analysed timbers feed into palaeoclimate and archaeological research both within ArcPal (*Brown, Plunkett*) and through external collaborations (*Brown*).

R&E provides knowledgeable pre- and post-award support, and expertise relating to knowledge exchange partnerships and impact. Faculty Finance teams offer one-to-one guidance with research applications, and ensure researchers are kept apprised of their budget status. SNBE has an efficient administrative framework with dedicated staff for each RC and Discipline, as well as a PGR Administrator. SNBE and Institutional incentives for research exist for staff of all levels (Table 2). Staff returning from maternity/adoptive leave have a semester free from teaching to enable them to resume their research.

Table 2. QUB and SNBE (italics) research incentives

All new staff	ECRs	All staff
Support package of £10,000	<i>Opportunity to apply for DfE PhD scholarship</i>	Reduced teaching/admin during probation
Funded place on PGCHET	PDRAs: 10 annual development days and the Research Development Framework	<i>Personalised Research Time allocation for unfunded research and proposal writing in WAM</i>
	Proposal Writing Training	<i>Dedicated RC for strategic networking, ECR development and training</i>
	Global Research Central Training, Conference Fund	Funding for e.g., engaged research development, networking
	ECR Development workshops	Advanced Career Researcher Development workshops

c. Operational infrastructure

ArcPal benefits significantly from a broad range of facilities that support research and innovation. The unit is mainly contained within a single building (ArcPal Building), with access to labs and facilities in other parts of SNBE, not least the staff Common Room and School Office in the neighbouring Elmwood Building. The ArcPal Building comprises individual office spaces for academic and academic-related staff (three fully refurbished since 2014), shared offices for CCA team leaders, PDRAs, Emeritus staff, Visiting Scholars and, during their grant periods, the FRAGSUS and Ranelagh teams. The SUNDASIA team shares a refurbished office in the Elmwood Building. PGRs and CCA staff have open plan office space. The ArcPal Building includes facilities that encourage interaction and promote a sense of community, including dedicated social and meetings spaces, and a newly designed student resource room. We also have access to world-class meeting facilities for hosting conferences and other research meetings, including a Mashme suite enabling up to 64 external parties to share interactive discussions and activities-

In addition to ¹⁴CHRONO facilities, we have an extensive range of well-equipped archaeology and palaeoecology labs, as well as specialist equipment, to support our wide-ranging lab and field research. PGRs and PDRAs who require microscopes have dedicated workspaces in the microscope labs. Requests for equipment and infrastructural enhancements are channelled to SNBE and Faculty via the RCs. Equipment maintenance is managed through SNBE's Lab budget.

We also avail of a wide range of facilities in SNBE, Faculty and, through collaborations, with other University departments. The School shares with the School of Maths & Physics a Scanning Electron Microscope fitted with a wavelength dispersive spectrometer for tephra geochemical analyses which has been central for the continuation of tephrochronology in ArcPal. ArcPal has been building links with Biomedical Sciences to develop capabilities in the analysis of aDNA, sedaDNA and microbiomes. With QUB's *Institute for Global Food Security* we are developing capacity in TQ-ICP-MS to complement ¹⁴CHRONO and SNBE's Stable Isotope Facility to deliver analysis in Sr and Pb isotopes for bioarchaeological and palaeoecological analyses.

Campus closure resulting from COVID19 restrictions impacted research in terms of lab access and fieldwork. Where research staff were able to progress with work remotely, they have done so with team meetings conducted virtually; CCA and some technical staff were furloughed. A number of mitigation strategies were put into place after the REF2021 period.

4. Collaboration and contribution to the research base, economy and society**a. Summary of collaboration and wider contribution**

As the only Archaeology department in NI, ArcPal has a pivotal role to play in ensuring the past is presented in a balanced, empirically-founded fashion, all the more in a region with a conflicted past. Since 2014, we have built bridges between local communities and civic authorities through engaged research. The scope of this engagement is not limited to NI, but extends to understanding, promoting and protecting shared heritage in other regions of the world. At the same time, we continue to grow our reputation for excellence in chronology-building and make substantive contributions to understanding climate change, reflected in the wide scope of our collaborative outputs with national and international peers and, through the academic significance of our work, to intergovernmental policy.

b. Academic collaborations and contribution to wider academic community

Our main collaborations and research networks have developed in response to our ambitions to enhance our engaged research, and through our individual and collective reputation as a leading centre for chronology development and archaeological enquiry. The global extent of our research connections (Fig. 7) is matched by our high proportion (78%) of co-authored outputs (of which 38% were led by ArcPal staff or ECRs). Our international field projects (*FRAGSUS*,

SUNDASIA) incorporate local institutions (Valetta, Hanoi) in wide collaborative networks. Other major international collaborations include *Blaauw's* NERC/NSF-funded MexiDrill project that brings together five UK-USA institutions, and his NERC-funded DeepChalla-UK project encompassing 11 institutions across the UK, Africa and USA. Megarry has been working with the African World Heritage Fund on project applications – including vulnerability assessment training in Tanzania and Nigeria – since the launch of the Climate Heritage Network in Edinburgh in 2019.

Key research on human and domestic origins has been enabled by our long-standing links with genetic specialists in Trinity College Dublin (*Murphy*, formerly *McCormick*). The QUADRAT DTP with UAbert has forged new collaborations, broadening the scope of our interdisciplinary research, with seven co-supervised PGRs recruited in the first two years of the programme.

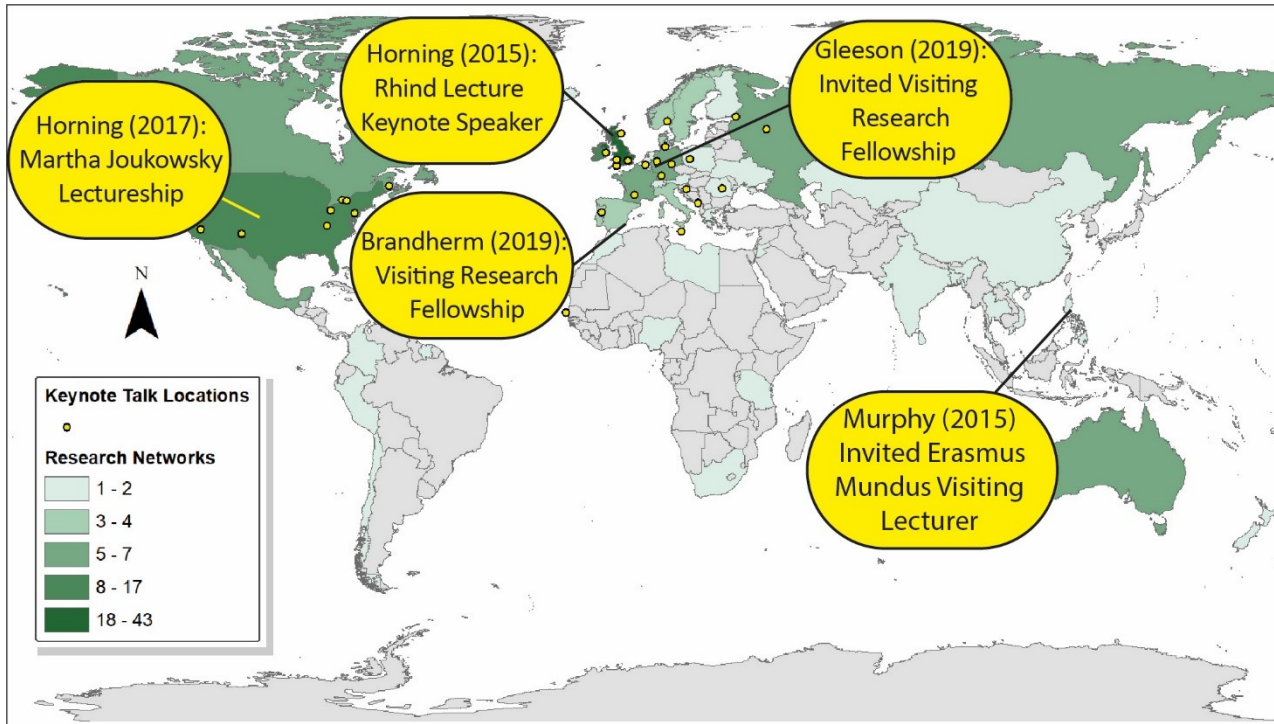


Fig. 7: Global breadth of ArcPal collaborations and research network, and locations of visiting/lecturing honours and keynote talks

We demonstrate leadership through key roles on working groups and advisory panels. We sit on committees of, for example, the Historic Monuments Council of Northern Ireland (*Megarry*), University Archaeology UK (*Murphy*), Royal Irish Academy (*Murphy*) and the Discovery Programme: Centre for Archaeology and Innovation (*Brandherm*), as well as the Leverhulme Advisory Team (*Malone*), through which we help shape national research agendas. *Megarry* is on the bureau of the ICOMOS Working Group on Climate Change and Cultural Heritage (2017–present) and is an expert member of the International Committee on Archaeological Heritage Management (2015–present); *Rabett* is a member of the Trang An Scientific Advisory Committee. *Reimer* has developed and chaired the international radiocarbon calibration (IntCal) group responsible for producing the world-leading ¹⁴C calibration datasets; this work has underpinned an enormous body of research in the fields of archaeology and palaeoecology (see *Reimer and Blaauw's* ICS).

Our achievements have been recognised by notable appointments and prizes. *Reimer* was elected to the Royal Irish Academy (2014). *Brandherm*, *Horning*, *Malone*, *Megarry* and *Murphy* are Fellows of the Society of Antiquaries of London and *Brandherm*, *Horning* and *Malone* of the Society of Antiquaries of Scotland. *Brandherm* is President of the International Union of Prehistoric and Protohistoric Sciences Commission 'Metal Ages in Europe'. In 2019, *Blaauw* was

invited to join the Advisory Board of the International Union for Quaternary Research's Stratigraphy & Chronology Commission. *Plunkett* is President of the Irish Quaternary Association and was on the Directorate of the Discovery Programme Centre for Research and Innovation (2015–2017). Our outputs have been recognised by the wider community (e.g., *Horning's* James Mooney Book Award and CHOICE Outstanding Academic Title, *Gleeson's* 2020 Martyn Jope prize). Other marks of success include invited research visits/lecturing series (Fig. 7). Fig. 8 summarises our contributions (mainly by invitation) to the academic community. Additionally, *Blaauw* has run 11 ECR-oriented age-modelling workshops (six by invitation) in nine countries, ensuring our strategy of supporting new researchers has international reach. We have hosted 12 national or international Visiting Scholars for knowledge exchange and training. ArcPal successfully bid to host the Paleoclimate Society PACS2020 (now 2021) and annual European Association of Archaeology (EAA) 2022 (now 2023) meetings. *Murphy* was recognised as Belfast Ambassador of the Year (2019) for her successful bid to host the EAA meeting in Belfast, in recognition of the expected economic benefits it will bring to the City.

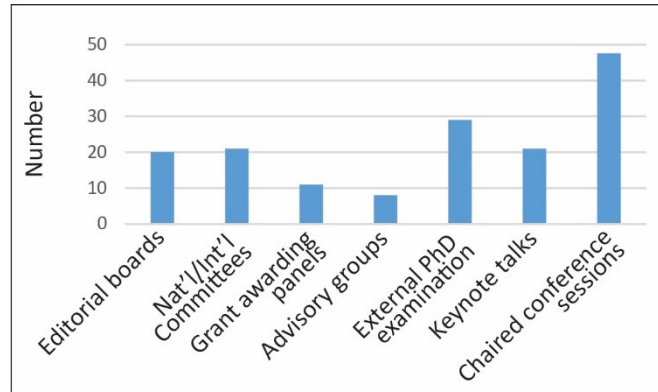


Fig. 8: ArcPal staff's measures of esteem

c. Engagement with non-academic communities

The CCA's Landscape Partnerships and our work with World Heritage Sites exemplify our commitment to engaged research (see *Malone, Rabett* and *Megarry's* ICS). Partnerships with public authorities, museums, community groups and private bodies maximise the impact of the work through local buy-in and promotion, and help deliver tangible outcomes on policy and practice. Building upon the success of the Tràng An World Heritage inscription, SUNDASIA's project partners include the Vietnam Institutes of Geosciences & Mineral Resources and Archaeology, Hanoi, the Ninh Binh Departments of Tourism and Culture & Sport, the Tràng An Management Board and Ninh Binh Provincial People's Committee, as well as Xuan Truong Construction Enterprise; individuals from several of these organisations have actively participated in the fieldwork. The FRAGSUS project has co-operated with local heritage organisations, including Superintendence of Cultural Heritage, Malta, and the National Museum of Archaeology, Heritage Malta, which hosted the FRAGSUS exhibition in 2018. The CCA engages with city and district councils, local and national museums, heritage trusts, community groups and private companies to raise the profile of archaeological heritage at local/national levels, and with the public through community archaeology, open days and festivals (Fig. 9). The CCA won QUB's Staff Excellence Community Impact Award (2019) in recognition of its inclusive engagement of people across Northern Ireland – of all ages, backgrounds and abilities – in the study of their heritage.

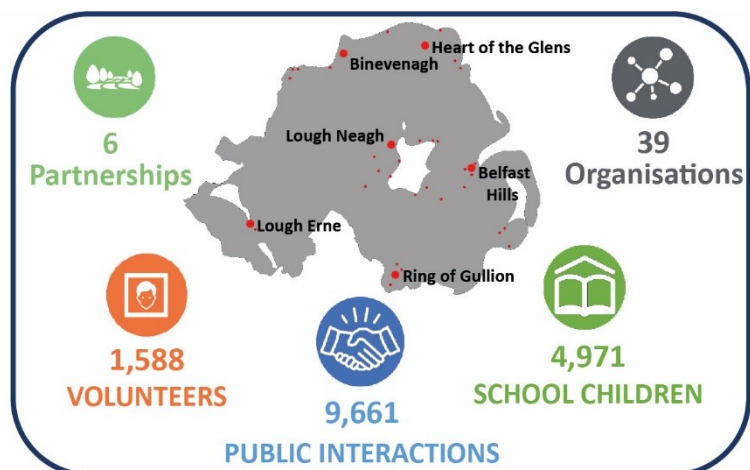


Fig. 9: Non-academic stakeholders and beneficiaries of the CCA's Landscape Partnerships and community-based archaeological fieldwork programmes

Communication of knowledge is a central tenet of our work, reflected by our contributions to many local and national outreach events, including annual contributions by staff, PDRAs and

PGRs to the Northern Ireland Science Festival. Ranelagh Osteoarchaeological Project staff undertook outreach events for school children as part of the Science Week Festival in the National Museum of Ireland, Dublin (2018–20). Since 2017, the CCA has co-organised the annual *Discovery!* public conference with the Ulster Archaeological Society, highlighting new archaeological research in Ireland (supported by C&S RC). In 2016, we organised and led a public seminar (>90 attendees) – *Archaeology of Atlantic Crossings: Early Explorations, Trade and Migration* – with the Ulster Museum. ArcPal hosts the longstanding Belfast YAC (led by *Murphy* and *Brandherm*), and staff have participated in 11 local primary school outreach events since 2014, in addition to >100 CCA events involving school children.

We reach a wide non-academic community through project websites (e.g., [SUNDASIA](#), [FRAGSUS](#)) and non-specialist media (magazine articles, TV appearances, podcasts and documentaries, such as the Smithsonian Channel's *Sacred Sites*). Our activities are widely shared through social media accounts (e.g., ArcPal's Facebook page has 3,900 followers), and our biweekly research seminars open to staff, students and the wider public. Our projects and research outputs have attracted significant media coverage (e.g. Plunkett's *PNAS* paper on Okmok's eruption impacts was picked up by 103 news outlets).

d. Wider impact on non-academic world and communities

Rabett is working in collaboration with the Tràng An Management Board (TAMB), provincial Department of Tourism and Xuan Truong Construction Enterprise to create a new exhibition space and museum storage facility focused on the cultural heritage of Tràng An aimed at the general public, school children and research. GIAA funding (2018) has provided resources for a film documentary, exhibition and training for 62 local staff in conservation practice as part of a broad-base collaboration to reintroduce the critically endangered Delacour's langur to Trang An (Table 1). A DfE-GCRF award (2020-21) to *Rabett* focuses on local community involvement in ecotourism at Tràng An (Vietnam) and the World Heritage site at Sinharaja (Sri Lanka) with a SOAS University of London economist, TAMB and the Munasinghe Institute for Development, Colombo, together with UNESCO offices in both countries.

The bridge-building work of the CCA and the Corrymeela project (*Horning*) highlights the positive role that archaeology can play in helping reshape public understanding of the past in societies moving out of conflict. The lasting benefits of these engagements, specifically in relation to attitudinal and cognitive values, are now being researched by a former CCA member as part of a PGR project (supervised by *Donnelly*).

Long-standing research by *Gleeson* at the Rock of Cashel, Ireland, and the Leverhulme-funded *Comparative Kingship* project, was pivotal in the design of a town park, and mitigated impacts on archaeology through the provision of public amenity linking this UNESCO WHS-nominated site with the town-centre as a part of urban re-generation work by Tipperary County Council.