

Institution: University of Lincoln
Unit of Assessment: 14 Geography
<p>1. Unit context and structure, research and impact strategy</p> <p>1.1 Context</p> <p>The UoA (with 15 permanent members as of 31 July 2020) is based in the School of Geography (SoG), University of Lincoln (UoL) which “represents one of the most significant investments in UK University Geography for a generation” (Dr Rita Gardner CBE, former Director of the Royal Geographical Society, RGS). Founded by Macklin in September 2016, it is the first entirely new HE geography institution in the country, which spans the entire sub-disciplines of human and physical geography, created since the inception of RAE in the late 1980s. SoG is focused around the theme of the Safety and Health of the Inhabited Earth (SHIE) that promotes the creation of healthy and safe environments in the places where we live. Our research programme addresses and seeks to respond to some of the most important environmental and societal global challenges of the 21st century. This SHIE theme enables us to improve understanding of the interdependencies of human and natural systems on a wide range of temporal and spatial scales, particularly in the context of ecosystem and human health, starkly relevant with cynosure of the current coronavirus pandemic and climate emergency. We use this framework to address social and bio-/geo-physical challenges ranging from crime and deprivation to pollution, natural hazards, meteorological prediction, and climate change causes and impacts, notably including droughts, floods and related human diseases.</p> <p>Our ambition is to consolidate and sustain a research team of emerging and established researchers within relevant SHIE disciplines to collaboratively develop a research environment that enables the integration of social and biophysical sciences and provides transdisciplinary solutions to these modern global societal challenges.</p> <p>1.2 Structure</p> <p>We have established at the heart of our strategic plans the multi-expertise Lincoln Centre for Water and Planetary Health (LCWPH) and the Development, Inequality, Resilience and Environments (DIRE) Group, which focus on new interdisciplinary research areas of societal importance as well as capitalising on the critical mass of research expertise of our new staff within SoG and more widely in UoL. These research clusters provide supportive and collaborative hubs for researchers from across UoL studying global environmental and societal challenges: LCWPH focuses on water-related research, pollution studies, meteorological prediction, climate change and especially its impacts, human and ecosystem health, while DIRE addresses diverse inter-and-transdisciplinary research into the upstream ‘causes of causes’ that produce inequalities in built and natural environments, and innovative methods of promoting development and resilience in vulnerable spaces. Facilitation of research within these clusters is promoted through regular (typically fortnightly) seminar series and conferences (typically yearly), hosting overseas research visitors (Australia, Chile, China, Italy, New Zealand), the provisioning of funding support and cross-disciplinary research supervision, including scholars/supervisors from the School of Life Sciences and the Lincoln Institute for Agri-Food Technology (LIAT), as well as from external stakeholders such as the Environment Agency (EA) and Met Office.</p> <p>LCWPH, co-led by Macklin and Thomas with Deputy Director Schuerch, is the first interdisciplinary research centre of its kind in the UK to focus on the most pressing environmental and societal issues emerging from water-related risks on human and ecosystem health in the world’s largest rivers and downstream coastal zones. LCWPH thereby provides the underpinning science for a series of UN Sustainable Development Goals (SDG). This includes fundamental research into seasonal weather prediction (e.g. Hall, Wei & Hanna 2019 <i>Q.J.R.Meteorol.Soc.</i> 145, 2568-2585, and NERC NE/V001787/1, PI = Hanna: SDG 13), hydrological and sea-level impacts of climate change and their remediation (e.g. Schuerch et al. (2018, <i>Nature</i> 561, 231-234: SDG 13-15), flood-related contamination from past and present</p>

metal mining and processing (e.g. Foulds et al. including Macklin 2014 *Sci. Total Environ.* 476, 165: SDG 3, 6), and water-borne and vector-borne diseases affecting humans and animals (e.g. Smith et al. 2020, *Nature Commun.* 11, 1-9 and NERC NE/P013481/1 FLOODMAL, PI = Thomas Co-I = Macklin: SDG 3, 15), as well as behavioural, political and economic adaptation mechanisms to mitigate environmental and human health impacts (e.g. Kythreotis et al. 2020 *Territory, Politics, Governance*, doi: [10.1080/21622671.2020.1837220](https://doi.org/10.1080/21622671.2020.1837220): SDG 13, 17). To understand these complex socio-environmental interactions and develop effective adaptation and mitigation strategies, we purposively undertake interdisciplinary research linking environmental sciences with humanities and human health and wellbeing (e.g. Thomas & Macklin NERC FLOODMAL project; Myers, Hemstock & Hanna 2020 *Science, Faith and the Climate Crisis* book: SDG 17). We also use the emerging idea of “Planetary Health” (“the health of human civilization and the state of the natural systems on which it depends”) and integrate it with river and catchment science to make this important concept operational for delivering evidence-based water and health interventions, notably through ARC (Murray-Darling basin; Macklin), UoL QR funding (Ganga basin; Macklin) and NERC (Zambezi basin; Thomas, Macklin) funded interdisciplinary investigations of some of the world’s largest rivers.

LCWPH’s strategy is to instigate a step change at the nexus of water, health and sustainability science by bringing together experts from climate change impact studies (Beck, Hanna, Hannaford, Kythreotis, Macklin, Mercer, Schuerch, Thomas, e.g. Toonen, Macklin et al. 2020 *PNAS* <https://doi.org/10.1073/pnas.2009553117>), global health, disease ecology and microbiology (Thomas, Macklin and Magnone, e.g. Cross, Thomas et al. 2020 *Parasites & Vectors* 14, #91), computer science, GIS and remote sensing (de Alwis Pitts, Hanna, Lechner, Ojo, Thomas, e.g. Lechner et al. 2017 *Environ. Model. Software* 93, 268-281), biogeochemistry (Magnone, Mercer and Macklin; e.g. Magnone et al. 2019, *J. Adv. Mod. Earth Sys.* 11, 327-337), geomorphology (Macklin, Mao, Schuerch; e.g. Mao 2018 *Geomorphology* 322, 196-205), ecosystem dynamics and services (Beck, Lechner, Mercer; e.g. Beck et al. 2020 *Environ. Pollut.* 265, 114695), and humanities and social science (Connolly, Hannaford, Kythreotis Moore, Ojo; e.g. Connolly et al. 2020 *Urban Studies* 58, 245-263). LCWPH has a significant and growing level of stakeholder engagement, including: the UK EA (Dr Sean Longfield, EA Lead Scientist for Flood Risk Research, is a Senior Fellow in LCWPH (e.g. Longfield et al. 2019, *J. Flood Risk Manag.* 12, e12449); the Centre of the Study of the Inland, La Trobe University (Australia) and Innovative River Solutions, Massey University (New Zealand) where Macklin holds adjunct chairs; in Zambia through the Zambezi EcoHealth Partnership (international partners Zambia Health and Water ministries, Canadian Coalition for Global Health); and the University of Namibia, where Thomas holds a Visiting Professorship. It has also established formal MoUs with the Department of Land Environment Agriculture and Forestry, University of Padova (Italy; Prof Tarolli), The School of Agriculture and Environment, Massey University (New Zealand; Prof Fuller) and The Department of Archaeology and History, La Trobe University (Australia; Prof Lawrence, honorary professor in LCWPH). LCWPH, has been particularly innovative in its use of art-science collaborations (e.g. Macklin and Macklin 2019, *Journal of Maps* 15, 9-18) led by Macklin and Judy Macklin (LCWPH honorary creative fellow) for outreach and knowledge exchange with major exhibitions in Australia, New Zealand, Spain and UK (<https://rivers-of-gold.com/art-science-collaboration/> and <https://botanicgarden.wales/visit/whats-on/event/exhibition-of-foresters-and-fish-tales-from-the-wildwoods-of-the-old-and-new-world/>).

The Human Geography **DIRE Research Group** led by Moore integrates research in the fields of social and environmental policy and justice, political ecology, environmental governance, disaster studies, public health and big data. Its primary aim is to champion evidence-based understanding of the causes of inequality in built and natural environments. This includes the identification of innovative methods of achieving social and environmental sustainability in vulnerable spaces through grassroots governance and planning strategies. This encompasses the social, environmental, cultural and economic factors that influence development, governance and policy trajectories across different geographical and temporal scales. Our members are engaged in internationally leading research networks in urban political ecology (Connolly: York University, Canada, *Urban Studies* 58, 245-263; University of Melbourne, National University of

Singapore, University of Technology Sydney and Australian National University [ARC-funded project on 'Mapping the Political Ecology of the Edible Birds' Nest trade in Indonesia']), water policy (Moore: University of Melbourne, e.g. *Environmental Management* 66, 202-217; and EU Horizon 2020 "Fairway" project), crime science (Ojo: CLEEN Foundation, Nigeria; lead-authored book on *Urbanisation and Crime in Nigeria published by Palgrave Macmillan*), the scalar governance of climate change (Kythreotis: University of Calgary and Saskatchewan and Wildlife Conservation Society, Canada, and University of Wollongong, Australia, *Front. Environ. Sci.* 7: 10, doi:10.3389/fenvs.2019.00010) as well as disaster studies and environmental history, especially in sub-Saharan Africa (Hannaford: Universities of Utrecht and Antwerp, Netherlands, co-authored book on *Disasters and History: The Vulnerability and Resilience of Past Societies*).

1.3 Review of strategy in census period

As SoG was only established in September 2016, our strategy to date is *de novo*. Our overarching aim is to produce the very highest quality interdisciplinary research addressing the major environmental and societal challenges of the 21st century. We have four **strategic objectives** which are to:

(I) Continue to strengthen the quality and reach of our publication portfolio, including publishing interdisciplinary research with leading international co-authors and research centres worldwide. This ambition has been fully achieved, as shown by our publications in a wide range of leading environmental and social science journals, including eleven papers in *Nature* (4), *Nature Climate Change* (2), *Nature Communications* (2), *Scientific Reports* (2), and *PNAS* (1). Up to July 2020, some 40% of our publication outputs were in the top 10 percentile of journals in the REF2021 period, compared with 35% for the UoA sector. A Google Scholar-based review showed that we have co-published with colleagues in 46 different countries, and that our collective citations on Google Scholar were >3000 per annum in 2019, increasing to ~5000 p.a. in 2020.

(II) Develop strong partnerships with external national and international stakeholders. These include the Tanzanian (mainland and Zanzibar), Zambian and Namibian medical and water authorities (Thomas and Macklin), New Zealand Ministry of Business, Innovation and Employment (Macklin), Met Office, European Centre for Medium-Range Weather Forecasts (ECMWF), US National Oceanographic & Atmospheric Administration (NOAA) and World Climate Research Programme (Hanna), Climate Change Expert Panel advising the H&S Executive on UK nuclear site risks (Macklin), Flood Risk Wales Executive Committee (Macklin), New Zealand Greater Wellington Regional Council (Macklin), UK River Restoration Centre (Moore), ICF (<https://www.icf.com/company/about>), Skills for Health, Skills for Justice, and Office of Police and Crime Commissioner (Ojo), City of Lincoln Council (Hanna, Kythreotis, Macklin) and the EA (Macklin, Magnone), evidenced in Section 4.

(III) Establish a base of research income from diverse sources. We have won funding from UKRI (NERC), the EU (Interreg Europe/Horizon 2020), British Academy and Australian Research Council (ARC), New Zealand, Ministry of Business, Innovation and Employment, Defra, Midlands Connect, the Greater Lincolnshire LEP and Natural England (NE) (see Section 3.2).

(IV) Establish a vibrant PGR and PGT community. We have grown a highly engaged PGR (recruited from the UK, Estonia and Japan) cohort of five (as of 31 July 2020; expanded to sixteen on 1 Oct. 2020), complemented by two postdoctoral researchers from India (Mudbhatkal) and the UK (Healey) who are supporting Macklin and Thomas, including LCWPH's internally-funded new research on emerging contaminants and spatial genomics of antimicrobial resistance in the Ganga and Tanzanian Lake Victoria basins.

Our **research impact strategy** is to:

(I) create a network of external partners to provide a springboard for impact development, outreach and knowledge exchange. To achieve this, we have tapped into our

existing and new local, regional and international contacts from the private (Delta Simons [Lincoln], Weston Williamson+Partners [London, Melbourne, Sydney, Toronto]), public (EA, NE, East Midlands Ambulance Service [EMAS], Zambian Ministry of Health) and third sector (RSPB, Lincs Wildlife Trust, River Trust, Diocese of Lincoln), to co-develop research around flood risk in the built environment, natural flood management, climate change mitigation and adaptation and public health concerns around malaria (SoG impact case study led by Thomas) and the COVID-19 pandemic.

One exemplar of our approach was the 2019 international conference “Moana – Water of Life: Navigating Climate Change for Planetary Health”, co-organised by Hanna with the Diocese of Lincoln, focusing on climate-change mitigation and adaptation, and whose 165 delegates included the general public, students, scientists and theologians from Europe, Oceania and North America. Macklin (plenary keynote) and Hanna, Kythreotis and Mercer (invited lectures) gave presentations at this meeting and contributed to its published proceedings. This event sets much of the framework for discussion of the climate crisis at the Lambeth Conference in summer 2022 when the bishops and archbishops of the worldwide Anglican Communion will come together to set church policy and priorities for the next decade. Many high-profile scientists (e.g. Prof Elisabeth Holland, Director of the Pacific Center for Environmental and Sustainable Development) and theologians (e.g. Justin Welby, Archbishop of Canterbury; the Rt Revd Dr David Court, Acting Bishop of Lincoln; Marc Andrus, Bishop of the Episcopal Diocese in California; Lynnaia Main, Episcopal Church Representative to the United Nations; Archbishop Emeritus Winston Halapua, former [Archbishop of New Zealand](#) & Primate of the [Anglican Church in Aotearoa, New Zealand and Polynesia](#)) contributed to the Moana conference and the resulting *Science, Faith and the Climate Crisis* book (co-edited by Hanna) that was published by Emerald in June 2020. This event and publication underpin a SoG impact case study led by Hanna.

(II) Strengthen the diversity of our School Advisory Board with research collaboration and impact in mind.

Through our Advisory Board, we have built strong links with external organisations including EMAS, the Greater Lincolnshire Local Enterprise Partnership, EA, Delta Simons Environmental Consultants (Macklin and Thomas) and NE. Sean Longfield (EA) works with Macklin as an external co-supervisor of Josephine Westlake’s PhD project on the augmentation of gauged flood series using palaeoflood data. Moore collaborates with Speight from EMAS to analyse the geographical spread of incidents of poor health and wellbeing across the region. Kythreotis and Mercer are working with Alex Ferguson, Delta Simons MD, on planning the Metanoia Festival as a direct follow-up to the Moana conference.

(III) Tap into the professional networks of colleagues to reinforce the breadth of geographical research conducted in SoG and create institutional rather than individual relationships.

Wherever possible, we have developed relations between several of our researchers and more than one individual in another UoA or external organisation. For example, SoG researchers are working closely with LIAT on several projects, including “SalFar” (Magnone, Macklin) and the EU Horizon 2020 “Fairway” Farm System Management & Governance (Moore). By co-founding the Lincoln Climate Commission and co-organising the Moana conference, we have established multiple working links with, among others, Lincoln City Council and the Diocese of Lincoln. Objective III is further evidenced in Section 4.

(IV) Consult diverse stakeholders in the design stages of new research projects, including end users of our research as project partners and co-funders.

For example, Hanna designed his NE/V001787/1 NERC grant in close collaboration with the Met Office and ECMWF as well as agri-food stakeholders (LIAT, Berry Gardens Growers Ltd, Weather Logistics) and the Sheffield Weston Park Museum. Section 4 has further examples.

These cases demonstrate our commitment to developing local impact as well as contributing to international research excellence.

1.4 Strategy for the future (research and impact)

Given the newness of SoG, we continue to pursue our strategic research and impact aims outlined above to strengthen the quality and reach of our publication portfolio by doubling the number of papers in leading (impact factor ≥ 5) journals and increasing our citations 50% by 2021/22 relative to 2019/20; develop existing and new research links with external stakeholders; double the number of named organisational links by 2021/22 relative to 2019/20; enhance a base of research income from diverse sources, and double research income by 2020/21 relative to 2018/19; and establish and strengthen a PGR community, doubling from the current 5 to 10 MPhil/PhD students by 2021/22. We embrace the UoL's strategy of producing "powerful research with impact", following its "local to global" principle of prioritising research that is relevant to our region and has global significance and enhances life both within and beyond our immediate community. We aim to further increase the quantity and quality of publications, wherever possible to embed impact in our research activities, and to increase the number of high-quality research proposals to UKRI, Charities, the EU, Government and industry and grow our research income (building on successes outlined in Section 3.2). External-research bidding is being facilitated through our annual seed-corn funding competition that was initiated in 2019. Progress on these aims is regularly monitored through our Research Committee. We also aim to further develop our PhD and PDRA communities (Section 2.3). Furthermore, we aim to increase the number of internal collaborations to address the SHIE themes identified in Section 1.1. Our interdisciplinary work responds to UoL's newly-identified strategic research themes (rurality, health and wellbeing, sustainability, digitalisation, communities, and heritage), and to funder priority areas including sustainable economies and societies, social justice, AI, clean growth, ageing society and population health. This will capitalise on the existing collective strengths and research strands of SoG members: for example Macklin, Mao and Schuerch on fluvial and coastal flood hazards and mitigation, Kythreotis and Mercer on climate politics, de Alwis Pitts, Hanna, Lechner, Ojo and Thomas using big data/AI, Macklin and Magnone on Environmental Pollution, and Beck, Connolly, Hannaford, Macklin, Moore and Thomas projects on political ecology, environmental history and psychology and human health impacts of disease.

As an example of how we plan to continue engaging with users and receivers of our research, we aim to use our recent Moana conference and Hanna's resulting co-edited book *Science, Faith and the Climate Crisis* to promote firmer public action on mitigating and adapting to future human-induced climate change, especially by influencing Anglican Church (a community of ~80 million people) policy on climate change globally. Our aspiration links well with the Sustainability – climate emergency theme recently identified by UoL in its new strategic research plan. Hanna has (autumn 2020) founded a **Lincoln Climate Research Group** which falls under LCWPH auspices and will strengthen a strong nucleus of SoG research and impact in this field by tapping into disparate expertise in this area across UoL. We will also build on the global reputation of our water and planetary health researchers (Macklin, Thomas) to continue the impact of their research into health risks arising from riverine contamination, flooding and disease vectors that flourish in riparian habitats. For example, they are leading new international UoL-funded programs modelling the global environmental impacts of metal mining and tailings dam failures supported by PDRA Mudbhatkal; antimicrobial and metal resistance co-evolutionary spatial dynamics (genomics) with metal contamination supported by PDRA Healey; and AI modelling of malaria prevalence in relation to hydrology in Africa (Thomas, PDRA TBA). Future research/impact activity will also involve the development of the DIRE Research Group referenced above, including strong collaboration not only with LCWPH but also other UoL centres, e.g. the Lincoln Institute for Rural Health Research and the Lincoln Centre for Ecological Justice, as part of its interdisciplinary research strategy.

2. People

2.1 Staffing strategy

Our School strategy has been to recruit staff with the breadth of expertise to cover all the sub-disciplines of Geography set out in the RGS benchmarking statement. This approach also enables interdisciplinary research collaborations, supported by LCWPH and DIRE as well as the mentorship of senior researchers in the School. The recent addition of Thomas as a Global Professor, and the 2020 award of a Distinguished Chair to Macklin, has further strengthened the research leadership. Since the establishment of SoG in September 2016, our recruitment ambition has been facilitated by the appointment of 15 academic staff from a wide range of disciplines, including biogeography and spatial ecology, climatology and meteorology, coastal and fluvial geomorphology, cultural geography, development studies, earth observation and GIS, environmental biogeochemistry, environmental psychology, historical geography, hydrology, political and social geography, soil science, Quaternary science and urban geography. Among these staff are three Professors, Macklin in river systems and global change, Hanna in climate science and meteorology and Thomas in water and planetary health, with a combined Google Scholar H-index of 154 (Macklin 73, Hanna 52 and Thomas 29), who lead and mentor a team of early- and middle-career academics from multiple institutes across the UK and internationally.

SoG's appointment strategy during its current early expansion phase has been to build up a team of independent-minded researchers who provide contemporary and complementary active research expertise across a wide spectrum of geographical sciences, with overlapping groups of highly active researchers coming together in different combinations to work on challenges in water and environmental health, climate change, and urban and rural well-being, with strong synergies between these fields already developing. Our strategy is to address practical global problem themes through having a flexible portfolio of in-house expert skills to help solve them, in conjunction with external collaborators, and with combinations of SoG staff as appropriate for the projects concerned.

2.2 Staff development

Staff research development discussions are based partly around themed research centre and group meetings and partly around the centralised but supportive Individual Research Planning (IRP) meetings, which provide formal reflection and planning in a context of individual mentoring (see institutional statement). We adopt a supportive mentoring approach and distinguish between line-management and mentoring meetings. Research support in terms of time allocation, funding for conference attendance and support for new project proposals is offered equitably across SoG. There is mandatory internal peer-review on all our research bids, alongside mentoring support, and normally a twice-yearly conference fund facility. All colleagues have equal opportunities to apply for conference funding and applications are assessed in terms of the quality of the paper, the value of the conference to the school and the personal development value for the individual researcher. In 2019 we initiated a new annual seed-corn fund for bids of up to £2000 to pump-prime research, and the first round of grants were allocated in January 2020. We also take advantage of central support from UoL Research Office which supports staff development by providing weekly bulletins on funding opportunities and training courses on bid writing as well as interdisciplinary research networking events and "sandpits". As part of their career development, postdocs are involved in the preparation of research proposals, e.g. with R.J. Hall having a key role in Hanna's successful NE/V001787/1 NERC bid. Our researchers greatly benefit from SoG policy that all academics have one "heavy" teaching semester and one "light" semester with only tutorial teaching, which offers ALL academic staff valuable time to focus on research, develop external collaborations/networks, and help achieve our strategic aims.

Our staffing strategy success is evidenced by our strong publication and growing external income portfolio and external collaborative networks that we have built over the last three years, despite a preponderance towards our faculty members being ECRs.

2.3 PGRs

As a recently-established and rapidly-growing school, as of July 2020 SoG hosted five MPhil/PhD students and two postdoctoral researchers, internally funded by SoG/LCWPH/UoL. Eleven MA/MSc by Research students were added in October 2020. The students benefit from close mentoring by their advisors, a dedicated SoG PGR/PDRA base room, and participation in SoG and LCWPH/DIRE research seminars. Every postgraduate student is supervised by at least two (MA/MSc) or three (MPhil/PhD) academic supervisors, which enables students to experience interdisciplinary research first-hand. Furthermore, our excellent student-staff ratio (~1:3) allows PGR students to receive academic and pastoral advice from a wide range of academics within the school, including early-career staff with no or little supervisory experience to our most senior supervisors with up to 50 completions recorded. Such diverse supervisory teams allow the students to draw on the expertise and experience of academics from different career stages, and early-career staff to develop their supervisory skills and benefit from input from their more experienced senior colleagues. SoG researchers are involved in cross-faculty supervision (e.g. Magnone co-supervises an EA-funded PhD project in collaboration with colleagues from LIAT) as well as at overseas institutions (Macklin co-supervises NZ government funded projects at Massey University).

Significant investment in research laboratories and equipment and recent recruitment of diverse research leaders has made the University attractive to potential students. The members of our growing postgraduate community are supported to develop their personal research profiles by attending University central training and tapping into the resources of the UoL's Doctoral School. The latter provides central courses that complement the close academic and pastoral support provided by SoG. Support for postgraduate research is led by the SoG Director of Postgraduate Research, who reports to the School Director of Research and Head of School, and the School Research Committee. Our PGRs regularly contribute to an annual 1-day, ~200 delegates UoL Postgraduate Research Student Showcase conference that includes research presentations, a poster session, 3MT competition, a research fair and keynote and plenary speeches. This highly cross-disciplinary event provides our PGRs with initial key experience which boosts their confidence to attend external conferences. Our PGRs are also involved in other scientific and outreach activities organised by the University, such as the Lincolnshire Show, 5 Slides in 5 Minutes, PhD in the Pub, Café Scientifique and Public Engagement with Research (PEARL) initiatives, and have established From Mountains to Molecules through Siren Radio.

Most recently, several of our PGR students collaborated with PGRs from other schools and colleges across the University to win an interdisciplinary research dissemination grant (£1,000) from the UoL PEARL funding stream. This demonstrates the vibrant and productive working environment in which SoG PGR students are immersed, benefiting from mentoring structures that allow them to develop their collaborative grant writing skills.

2.4 EDI

Over three years a diverse and balanced team of academic staff has been appointed, with a broad age profile and highly diverse nationalities/countries of origin. Our 15 permanent academics originate from a wide variety of nations, including the UK, Italy, Switzerland, Nigeria, Sri Lanka, Canada and Australia, and have held previous academic/research positions in many different institutes in the UK, Netherlands, Germany, Italy, Singapore, Brunei, USA, Chile, Australia and New Zealand. This provides a great blend of research contacts and experiences and a truly global perspective on many of the key social and environmental challenges currently facing humanity. We also have a good representation of BAME (32.5% of our faculty members compared with 8.9% of UoA14 staff nationally). Staff ages range between 28 and 63, with a strong weighting (11/15) towards the 30s and early/mid 40s, reflecting a diverse and balanced range of experience and career stages. Moreover, 5 out of these 15 staff are early-career researchers, which we here define as being within 5 years of their PhD award (as of 2020), while 7/15 staff are in their first permanent academic position. Some 35.1% of our faculty members are aged 34 or under, compared with 27.3% for the sector nationally. Our ECRs are closely

mentored by senior staff members and, alongside all academic staff, benefit from our flexible working and semesterised teaching policies (see above). Flexible/home research working is encouraged, and particularly helps those staff with caring responsibilities. Our staff benefit from centralised EDI training and social events for international staff. We are keen to further enhance our diversity, especially regarding gender balance (as of July 2020 our 15 faculty members included 4 female academics, which is a relatively low proportion compared with UK geography nationally = 37.6%). Therefore, during the 2020-21 academic year we will appoint an Athena Swan representative for the school, under guidance from the UoL's Eleanor Glanville Centre, and it is our intention to apply for the Athena Swan Bronze Award ASAP thereafter, meeting the institutional plan of a target date of 2022 for all Schools. We give careful regard to gender issues during recruitment (e.g. by ensuring diverse shortlisting/interview panels; panel members receiving unconscious bias training), and include ECRs on all key SoG committees, including research committee where we have EDI as a standing item. Early-career researchers are supported through the conference and seed-corn funds described above and by our policy, wherever possible, of pairing them with senior academics to co-supervise PhD students. By utilising the UoL's new research priorities (e.g. Rurality, Health & wellbeing, Sustainability, Digitalisation, Heritage and Communities) and framework (e.g. the recent appointment of Global Chairs including specifically Kirk, Tanser and Thomas), our early- and mid-career staff members, with proven track records, are in the early stages of co-designing new ventures within the themes of this UoA. We hold regular (annual) research away days and more informal events to help with staff integration and to reflect and enhance our research culture.

3. Income, infrastructure and facilities

3.1 Infrastructure and facilities

Facilitated by a generous start-up fund from central University resources (~£8M for staffing/developing SoG during the current REF cycle) and a clear research pathway, the School has been able to quickly establish a research intensive, purpose-built sediment/soils lab and IT suite. These facilities are supported by a range of modern laboratory and field equipment that enable our researchers to monitor the inhabited Earth and therefore improve understanding of the inter-dependencies of human and natural systems on a wide range of temporal and spatial scales. There is also additional generous investment from UoL from 2019 in the form of a Global Chair in water and planetary health. This has been used to develop field research platforms in Zambia/Tanzania through procurement of field equipment including three vehicles and a boat, field genomics equipment (Oxford Nanopore Technologies Ltd), and to establish dedicated malaria vector and AMR genomics facilities in UoL Joseph Banks Laboratories (see below). Our academic team is supported by two senior ICT and laboratory technicians who hold PhDs, and three dedicated administrative staff.

To capture social and physical (e.g. land use, vegetation, sediment, soil) data at a broad scale the School has invested in UAV equipment (Multirotor blackbird, DJI matrice and mavic pro) that enables our researchers and students to create detailed maps of large areas. Standard photogrammetric techniques are used to create DEMs (utilising Agisoft software) that can be utilised to aid flood prediction, whilst scans with our Micasence near-IR camera facilitate plant-health monitoring.

To observe meteorological fluxes the School has set up its own on-site, industry-standard weather station (Davis Vantage Pro2 Plus FARS), which was installed on the rooftop of the Isaac Newton Building in December 2018 as a University-wide research facility, and has also purchased a mobile weather station (Davis Vantage Vue) and albedometer (CMA6 from Omni instruments).

At the field scale, SoG has also invested in technology for monitoring soils, sediment and water quality. SoG has also acquired a peat corer, a Livingstone corer and a universal sediment corer. A Dando Terrier Mk2 drilling rig, capable of coring soil and sediment down to 15 m is currently being employed by LCWPH-funded PhD researchers (supervised by Macklin

and Magnone) reconstructing flood histories for improving flood risk assessment and exploring the abundance and distribution of emerging contaminants in river systems in the UK and Ganga River (India; UoL central funding). The flexibility of owning our own rig has resulted in SoG rapidly creating a pioneering core archive containing hundreds of meters of material sampled from around the Witham, Trent and Ouse catchments. This set of sediment-coring equipment allows SoG to collect samples of natural archives from a wide array of environments.

These instruments, coupled with a new research-quality Zeiss AxioScope microscope, enable our researchers to examine microscopic samples important for palaeoecological research. SoG's Niton portable XRF analyser is routinely used to chemically characterise all core samples. Physical characteristics, such as grain size, are established using a state-of-the-art Malvern Mastersizer 3000E housed in SoG's sediment/soil lab.

SoG has also invested in water-sampling and -monitoring technology. An ISCO 6712 automated water sampler with environmental trigger, as well as an YSI ProQuatro meter, form part of a series of equipment that has been purchased to monitor water quality (pH, DO, conductivity and ORP) in both freshwater aquatic and coastal environments.

SoG's IT suite has computers equipped with the latest research and teaching software, including ArcGIS, ENVI, MATLab, Qualtrics and SPSS. There is also an AV system and a breakout area where weekly research meetings take place.

The School also benefits from the £12.7M facilities already established in the Joseph Banks Laboratories (JBL). JBL's state-of-the-art infrastructure has enabled our researchers to create a dedicated wet geochemistry lab suitable for extracting pollen, emerging contaminants and DNA from soils and sediment. As SoG's research develops, we plan to further utilise JBL's analytical instrumentation including the NMR, ICP-OES, FTIR, AAS, GC-MS, GC-FID, HPLC, AAS, Raman, FTIR, UV spectroscopy, Ion Chromatography, XRD, SEM (see institutional statement).

As part of a successful £4M competitive EPSRC bid including UoL, from 2020 SoG has access to The Young tier2 High Performance Computing facility that is operated by the UCL Research Computing team. This will significantly benefit supercomputing research conducted by SoG researchers, such as by Hanna in Greenland Ice Sheet surface mass-balance modelling (e.g. Fettweis et al. 2020 *Cryosphere*, tc-2019-321).

3.2 Income

SoG research is externally funded by UKRI (NERC), Interreg Europe, Horizon 2020, British Academy, Australian Research Council (ARC), and Chilean National Commission for Scientific and Technological Research, which support PhDs and PDRAs. Demonstrating our commitment to the region, SoG researchers have carried out funded projects for Defra (£60,000 & £140,000), Midlands Connect (£29,000) and the Greater Lincolnshire LEP (£30,000) during this REF period too. We have established this diverse funding portfolio by providing staff with protected semesterised research time, described in Sect. 2.2. Total research income for 2018/19 was £89,000, which is on a strong upward trajectory (e.g. with Hanna's NERC NE/V001787/1 award notified in July 2020). Funded projects are across a broad range of SHIE issues (e.g. climate change impacts on disease and coastal adaptation, seasonal weather prediction, rural resilience, climate-change politics, river systems and impacts under environmental change/hazards, political ecology) and therefore perfectly fit the interdisciplinary SoG/LCWPH research ethos.

LCWPH is part of a consortium which was awarded £606,540 (£148,929 to UoL) by the Natural Environment Research Council for the FLOODMAL project, led by Thomas (PI) with Macklin as Co-I, that works with other universities to investigate links between flooding controls and the spread of malaria. This research focuses on the Zambezi River in Zambia. Macklin in 2018 secured central UoL QR GCRF funding on the Ganga/Ganges, and is part (Discovery International Fellow) of an ARC-funded project on a "Rivers of Gold: The legacy of Historical

Gold Mining” (650,187 Australian dollars) on the Murray-Darling river basin, Australia, and Ministry of Business, Innovation and Employment (New Zealand) Endeavour Fund award (funded adjunct professorship) for “Smarter Targeting of Erosion” (750,000 New Zealand dollars) on the Manawatu and Whanganui rivers, NZ. In July 2020 Hanna was awarded £650,032 from NERC for leading NE/V001787/1 on “Northwest European Seasonal Weather Prediction from Complex Systems Modelling”, working with the Universities of Oxford, Reading and Sheffield, Met Office and ECMWF. Mao is PI of a £216,000 project funded by the Chilean National Commission for Scientific and Technological Research (CONICYT) on the flood memory of a river system. He is also Co-I on another £216,000 CONICYT project on morphological impacts in rivers affected by volcanic eruptions. Furthermore, Mao is leading a The Nature Conservancy project on hydrological monitoring of high-elevation wetlands in central Chile, focusing on glacial-fed systems which are severely threatened by climate change.

Human geography staff have two active projects with the British Academy: in August 2019 Kythreotis was awarded £9,787 of BA funding to research “A new civil politics of climate change”, while in July 2020 Ojo was awarded £9,958 for his project “The Nexus Between Social Capital and the Burden of COVID-19 in the United Kingdom”. In April 2020 Connolly was awarded an ARC Linkage Grant (A\$159,800 over 3 years; c. \$25,000 to Lincoln) on ‘Mapping the Political Ecology of the Edible Birds’ Nests Trade in Indonesia’, in addition to a smaller Landscape Research Group fund (£2012) ‘Evaluating extended urban infrastructure landscapes under China’s Belt and Road initiative’. Moore is involved with an EU H2020 (“Fairway”) grant aimed at assessing the effectiveness of EU water policy in improving water quality in the EU. Connolly has recently completed (as Co-I) a Singapore National Heritage Board (NHB)-funded Research Grant project documenting the in/tangible cultural and natural heritage of Singapore’s Southern Islands and the fluidity between these categories. The findings of this project were displayed in a NUS Museum exhibition in early 2019 and featured by the Sentosa Development Corporation as part of Singapore’s bi-centennial celebrations.

Until April 2020 Bosworth (DHoS 2016-2020) (succeeded by Gould after Bosworth’s departure, with Magnone now co-ordinating from SoG) led the UoL’s contribution to the 6M EUR SALFAR: a 4.5-year EU Interreg North Sea Region project which is exploring the potential with farmers in coastal areas for developing saline agriculture to counter threats of sea-level rise and increasing soil salinity. Bosworth supported the work of the Midlands Engine Research Observatory and was awarded £29,000 funding to carry out a study exploring the Future of Rural Mobility in the Midlands region. Bosworth was also awarded £150,000 by Defra (50% to Lincoln & 50% to Newcastle) to fund a preliminary phase of an ESRC grant proposal investigating rural entrepreneurial emergence.

Our ECRs are already being successful in winning external funding support with for example, Beck securing (July 2020) £10,500 from the National Environmental Isotope Facility, as a NERC ‘Grant-in-kind’. Beck (with Schuerch) also recently won a £1250 grant from the Quaternary Research Association on “The ecological implications of seawall removal at Gibraltar Point, UK from a palaeoecological perspective”, which built on Schuerch’s November 2018, award (£1,000) from the British Society for Geomorphology to take a “A long-term perspective on barrier-marsh interactions”.

4. Collaboration and contribution to the research base, economy and society

4.1 Research collaborations, networks, and partnerships

SoG staff collectively have a wide range of international research backgrounds and nationalities (detailed in Sect. 2.4), especially for a relatively small and early-career group, which has allowed us to tap into our many and diverse collaborative research links across the world.

In LCWPH, Macklin, evidenced by his recent (September 2020) award of a Distinguished Chair in River Systems and Global Change, continues to make significant contribution to the research base, economy and society worldwide through his funded research networks in Africa (notably in

the Desert Nile with the British Museum, University of Manchester, Yale University; e.g. Macklin et al. 2015 *Quat Sci Rev* 130, 109-123), Australia (notably in Victoria with University of Melbourne, La Trobe University e.g. Davies et al. 2018 *Anthropocene*, 21, 1-15; and Queensland with Griffiths University and Uni. Queensland e.g. Lam et al. 2017 *Water Resour. Res.* 53, 2312-2327), Central Asia (with University of Arizona, VU University Amsterdam, JSC Institute of Geography and Water Safety, Kazakhstan e.g. Macklin et al., 2015 *Quat Sci Rev* 129, 85-95), Europe (with Museo Nacional de Ciencias Naturales (Madrid), Lomonosov Moscow State University, University of Padua, University College Dublin, Leipzig University e.g. Benito, Macklin et al. 2015 *Sci. Rep.* 5:16398) and New Zealand (with Massey University e.g. Fuller, Macklin et al. 2018 *Geomorphology* 310, 102-124). In the UK Macklin has been a senior advisor to key research users including DEFRA (e.g. Hallas et al. 2017 *In Situ Contaminated Sediments Project–Work Package 1A Report*) in relation to the assessment and remediation of river contamination related to historical metal mining, and to EA and JBA (e.g. Dixon et al. 2017 *Making better use of local data in flood frequency estimation*) for improving flood risk. Thomas, NERC FLOODMAL PI, collaborates on flooding and malaria transmission in the Upper Zambezi, and is an external leader in the Zambezi EcoHealth Partnership formed by the Zambia Ministry of Health, Zambezi Water Resources Management Authority and the Canadian Coalition for Global Health Research (CCGHR), a knowledge network for global health equity active in 49 countries and involving over 20 Canadian Universities. He is Co-I of an Innovative Vector Control Consortium (Gates, DfID, Wellcome trust, US AID) project working with the Zanzibar Health Authorities to contribute to a major malaria elimination campaign in Tanzania. Mao co-chairs the Denudation and Environmental Changes in Different Morphoclimatic Zones working group of the International Association of Geomorphologists (<http://www.geomorph.org/denuchange-working-group-4/>).

In climate science and impacts, Hanna regularly collaborates with NOAA in carrying out an annual update of its Arctic Report Card. He is the World Meteorological Organisation/World Climate Research Programme representative on the Ice Sheet Mass Balance and Sea Level (ISMAL) expert group. He worked with external colleagues on the £2.4 million NERC-funded Black & Bloom project (2015-2020) to determine the causes of Greenland Ice Sheet melt under climate change, and is a member of the Ice sheet Mass Balance Inter-comparison Exercise (IMBIE2) international project team on estimating recent changes in ice-sheet mass balance, co-authoring *Nature* (558, 219 and 579, 233). Hannaford is a co-founder of the international 'Historical perspectives on climate change adaptation' research group (e.g. Adamson et al. 2018 *Glob. Environ. Change* 48, 195-205). He has been working in close collaboration with Utrecht University on an European Research Council-funded project (Grant ID 339647), which aims to identify the key drivers of societal resilience to climatic, epidemiological and geomorphological hazards over the past 500 years in the North Sea basin, and has a resulting co-authored CUP book "*Disasters and History: The Vulnerability and Resilience of Past Societies*". Hannaford also leads the Southern African working group of the Past Global Changes (PAGES) LandUse6k project (*Past Global Changes Magazine* 26, 8-9). Schuerch et al. (2018, *Nature* 561, 231-234) led an international team of researchers to develop a new global-scale model on the response of coastal wetlands (including salt and freshwater marshes and mangroves) to sea-level rise, emphasizing the importance of coastal management.

Our human geographers are equally active with external networks and partners. Ojo helped to develop an innovative City Infrastructure Quality Index (Ojo et al. 2018 *Urban Science* 2, 59), and in 2019 lead-authored a book on *Urbanisation and Crime in Nigeria* (Palgrave Macmillan). He has recently worked with the Office of Police and Crime Commissioner, Merseyside to capture and detail the depth and breadth of financial cuts among a wide range of Merseyside Community Safety Partners (e.g. Ojo et al. 2020 *Policing: A Journal of Policy and Practice* 14, 389-403). Moore is a founding member of two research groups focused on understanding the spatial distribution and causes of ambulatory sensitive health conditions. Emergency Medical Services Call Condition Clusters (<https://www.cahru.org.uk/research/pego/emsc3/>) is collaborating with EMS in Ontario, Canada, to conduct a comparative analysis of pre-hospital medical conditions, including diabetes, mental health conditions and respiratory conditions. COVID-19: Clusters, Causes, Triage and

Vulnerability (<https://www.hra.nhs.uk/planning-and-improving-research/application-summaries/research-summaries/covid-19-clusters-causestriage-and-vulnerability-covid-19-cctv-covid-19/>) is focused on evaluating environmental, socio-economic and medical factors controlling the evolution of suspected and confirmed COVID-19 cases in the East Midlands by identifying unusual clusters of cases. Moore is also working with landholders and catchment management groups (e.g. North Central CMA) in rural Victoria, Australia, to improve the quality of data collected about the progress of river restoration projects (Moore & Rutherford 2020 *J. Rural Studies* 76, 296-304). Connolly collaborates with colleagues from York University (Canada) on the relationship between urbanisation and infectious disease (*Urban Studies* 58, 245-263), resulting in numerous invited talks/keynotes at top Universities around the world: e.g. LSE Southeast Asia Center Public Event, 5 June 2020; International Institute for Asian Studies/Urban Knowledge Network Asia Asian Cities Presentation Series webinar, 23 June 2020. Connolly also works with colleagues at universities in Australia and Singapore, and NGOs in Indonesia, through his new ARC Linkage Grant.

4.2 Relationships with users, beneficiaries & society

SoG researchers are involved in diverse high-profile end-user activities. For example, Moore has been working throughout the COVID-19 pandemic to provide near real-time output for immediate use by EMAS, informing paramedic training. COVID-19: CCTV also examines the impact of the pandemic on mental health during isolation to inform a parliamentary enquiry led by Dr Sarah Bunn. Connolly recently completed a Singapore NHB-funded project titled 'Mapping the Southern Islands' heritage landscapes: Integrating culture and nature in urban heritage conservation', which generated significant local impact through a museum exhibition and guided public tours of the islands. Mercer is involved in stakeholder-focused activity related to the NERC-funded Biodiversity and Ecosystem Service Sustainability project (having worked as a Research Fellow at Cranfield University on NE/J015369/1 and NE/J015067/1). She also leads an interdisciplinary research project to show how a 5-year woodland management plan (Hill Holt Wood, Lincoln) both addresses bio-physico-chemical issues and facilitates the development of the site as an urban greenspace. Hanna participates in a project led by Prof. Grant Bigg (University of Sheffield), which has developed a novel machine-learning model to predict the severity of the annual iceberg flux into the shipping lanes of the Northwest Atlantic off Newfoundland. Model output have been provided since 2017 to the US Coast Guard's International Ice Patrol as a tool to contribute to their seasonal ice hazard prediction services (Bigg et al. 2019 *J. Operational Oceanography* 14, 24-36). Kythreotis is a co-founding member in spring 2019 of the Lincoln Climate Commission (also involving Hanna and Macklin). LCC emerged from collaboration between the City of Lincoln Council, Siemens, Transition Lincoln and UoL. Influenced by SoG/LCWPH research on climate science and politics, in July 2019 Lincoln City Council, acting through LCC, ambitiously adopted an area-wide target of zero net carbon by 2030.

4.3 Wider contributions to research base

Several staff are involved in **inter/national review panels**. Macklin and Hanna are current members of NERC's Peer Review College and Hanna served on a 2016 NASA review panel and as a member of the NASA/European Space Agency Interagency Gravity Science Working Group (Doc. nr. TUD-IGSWG-2016-01). Following several years as a NERC PRC chair, Thomas was an invited expert assessor for the Belmont Forum Climate, Environment and Health international Collaborative Research Action (2019). Hanna is a member of the EU International Network for Terrestrial Research and Monitoring in the Arctic Transnational Access Evaluation Board and hosted their panel meeting in Lincoln in January 2020. Kythreotis is an invited external reviewer for the UK Committee on Climate Change's Climate Change Risk Assessment 2022, having served as a reviewer of the 2017 DEFRA CCRA, advised the Prime Minister's Office of the Bruneian Government on their Nationally Determined Contributions for the UNFCCC Paris Agreement (2018), and sat on the adaptation sub-board of the Climate Change Commission for Wales (2014-2016). Macklin serves on the steering committee of PAGES Floods Working Group, is a member of the Climate Change Expert Panel advising the Health and Safety

Executive on climate-change risk for nuclear sites in the UK, and was appointed by the Environment Minister of the Welsh Assembly Government to the Flood Risk Management Wales Executive Committee (2006-2016).

Staff members serve(d) on the **editorial or advisory boards of major journals**, including *Journal of Hydrology* and *MDPI Geosciences* (Mao), *Journal of Soil Science & Plant Health* (Mercer), *The Cryosphere* and *MDPI Atmosphere* (Hanna). Our staff have served as **PhD external examiners** for the Universities of Liverpool, Southampton, Bologna and Ferrara (Italy) (Mao); the Universities of Northumbria, UEA/British Antarctic Survey and Utrecht (Netherlands) (Hanna); and University of Durham and Vrije Universiteit Amsterdam (Netherlands) (Macklin) and as **external doctoral supervisors**, e.g. University of Sheffield (Hanna), Griffiths University and Massey University (Macklin), London Metropolitan University (Ojo) and University of Kiel (Schuerch). **Recent international keynote/invited lectures** by our staff include: International Institute for Asian Studies/Urban Knowledge Network Asia Asian Cities Presentation Series and LSE Southeast Asia Center Public Event (both Connolly); American Geophysical Union Fall Meeting 2019, Arctic Air-Ice-Sea Interactions and Their Possible Roles in Extreme Weather and Climate Occurrence workshop in Anchorage (Alaska, USA), NERC North Atlantic Climate System Integrated Study 2019 Summer Science Meeting, and the Nansen Environmental Remote Sensing Center, Bergen, Norway (Hanna); Yale University Nile lecture series 2018, USA; 6th International Palaeoflood Conference 2020 Massey University, New Zealand (Macklin); the Binghamton Geomorphology Symposium 2018, Syracuse University, a University of Bozen/Bolzano sediment management workshop in 2018, and the 4th conference on Wood In World Rivers in Chile in 2019 (Mao); and the Urbanisation Research Nigeria Conference in 2018 (Ojo). Our staff have **convened major international events**, including an ISMASS research workshop on ice-sheet mass balance as part of POLAR2018 at Davos, Switzerland in June 2018 (Hanna), the 6th International Palaeoflood Conference 2020 Massey University, New Zealand (Macklin), and EGU2020/session/37472 on Coastal wetlands (Schuerch).

Staff members have received significant national and international **awards**, including the Royal Geographical Society's 2018 Murchison Award, the 2016 ARC Discovery International Fellowship and election in 2014 as an inaugural Fellow of the British Society for Geomorphology (Macklin); the Royal Meteorological Society's 2018 International Journal of Climatology Editor's Award (Hanna) and the Institute of Marine Science, Engineering and Technology's 2020 Denny Medal JOO (Hanna, co-recipient); and a 2017 award from the Merseyside Police Force for the impact of research and capacity-building efforts (Ojo).