Department for the Economy
www.economy-ni.gov.uk

GSNI Geological Survey of Northern Ireland
www.bgs.ac.uk/gsni

Annual Report 2019-2020

Contents

Cover image. The Beach at White Rocks, Co. Antrim. © Tourism NI Media Library

Introduction

The Geological Survey of Northern Ireland (GSNI) is an office of the Department for the Economy (DfE) in Northern Ireland staffed by scientists of the British Geological Survey (BGS) based in Dundonald House, Belfast.

GSNI provides geoscience data, information, analysis and advice to support the legislative responsibilities and strategic priorities of DfE, other NI government departments and local Councils.

GSNI's datasets are available on Open Data NI and Spatial NI. GSNI also hosts data and information on geology, engineering geology, minerals, borehole data and site records, mines, quarries and pits, airborne geophysics, soils and water geochemistry on GeoIndex.

The GSNI office is based at Dundonald House on the Stormont Estate, Belfast where it runs an enquiry service and shop; it also manages a national core store and sample repository at Duncrue Industrial Estate.

GSNI actively engages and works with all parts of society including central and local government, industry, academia, community organisations, NGOs, schools and the general public. GSNI staff collaborate on applied geoscience research with BGS, the Geological Survey of Ireland and over 35 universities globally.

This annual report summarises how GSNI performed in the financial year (FY) 2019–2020 and the benefits its work have had on Northern Ireland's economy, infrastructure, environment, tourism, health and education sectors.

One of the most significant pieces of work has been GSNI's contribution to the Northern Ireland Department for Economy's Call for Evidence for its Energy Strategy. GSNI's submission in February was one of 166 submissions from across NI's civic society. This marks the beginning of a process that will shape and inform an Energy Strategy for Northern Ireland that will enable new and challenging decarbonisation targets as the UK has committed to a 100% reduction in greenhouse gas emissions by 2050. As a consequence of this submission, GSNI scientists were invited to join DfE's Heat Working Group on the Energy Strategy; GSNI also moved within DfE to join its Energy Group.

Dr Marie Therese Cowan PGeo, MIoD
Director, Geological Survey of Northern Ireland

Our structure

The Geological Survey of Northern Ireland (GSNI) is an office of the Department for the Economy (DfE), herein referred to as 'the Department'. GSNI is staffed by scientists of the British Geological Survey (BGS) under contract to DfE.

Governance and Administration

The GSNI Director, supported by two business assistants, is responsible for the governance and administration of the organisation, including strategic direction, leadership, finance, stakeholder engagement and partnerships, health, safety and wellbeing, continued professional development of all staff and monitoring and reporting on performance. GSNI's research programme is delivered by three teams as outlined below.

Energy, Minerals and Waste

The Energy, Minerals and Waste (EMW) team provides advice and support to the Department on resources and energy-related issues including oil and gas exploration, geothermal energy, underground energy storage and carbon capture and storage. The EMW team also provides geoscientific advice and support on the economic development of natural resources and assists Minerals and Petroleum Branch of the Department with minerals licensing. The team contributes to policy development for minerals and energy through the provision of scientific advice and data.

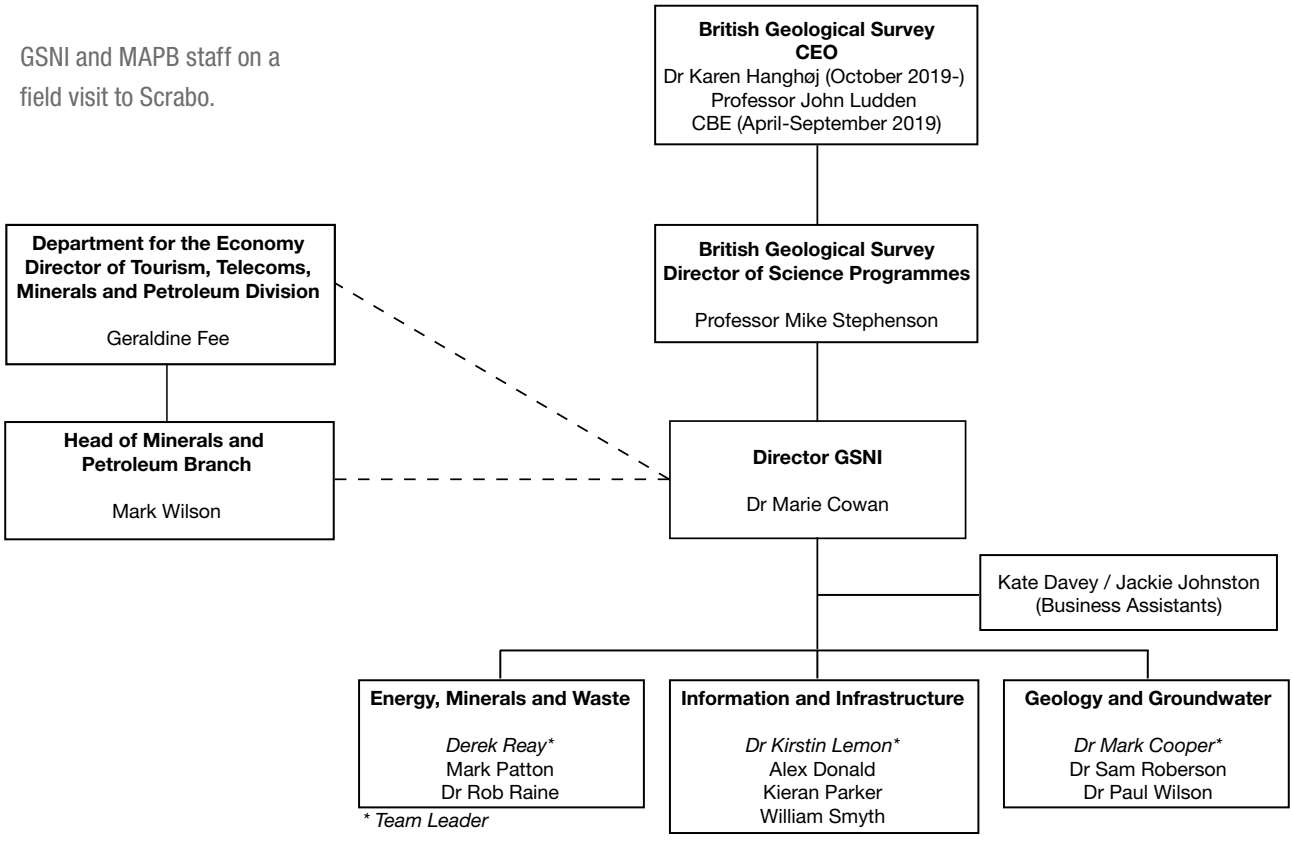
Information and Infrastructure

The Information and Infrastructure (II) team provides geological information through the enquiries service to external customers and stakeholders, ensures that GSNI's data is collated, managed and distributed effectively, and responds to planning consultations through the local council and regional planning process. They are also responsible for the monitoring of Northern Ireland's abandoned mines many of which are vested in the Department, and contribute to the development of geological tourism and education resources.

Geology and Groundwater

The Geology and Groundwater (GG) team provides information on the extent, thickness and properties of geological materials, primarily in the form of bedrock and superficial geological mapping. The GG team also provides information and advice on groundwater resources in Northern Ireland and contributes to groundwater monitoring.

GSNI and MAPB staff on a field visit to Scrabo.



The GSNI Senior Leadership Team is the main decision-making body of the GSNI and has responsibility for the corporate governance of the survey. The responsibility for leading the strategic direction of GSNI lies with its Director. GSNI is supported by BGS staff in finance, human resources, contracts and IPR, learning and development, IT and communications. The GSNI Director is a member of the senior leadership teams of the Department for the Economy in Northern Ireland and BGS and reports to both the DfE and via BGS to UKRI.

Governance

GSNI Science Advisory Committee

Under the terms of the Service Level Agreement (SLA) that the GSNI (UKRI) signed with DfE, a new GSNI science advisory committee (SAC) was formed and held its first meeting on 19th September 2019.

Following a call to over twenty organisations from across government, academia, industry and the third sector for nominations to the SAC, the main purpose of which is to advise GSNI on the development and delivery of GSNI's public role and its science strategy, the composition of the committee is:

- Professor Paul Dunlop (Chair), Research Director, Geography & Environmental Sciences, University of Ulster
- Gordon Best, Director, Mineral Products Association Northern Ireland
- Professor Maeve Boland, Senior Geoscience and Policy Specialist, University College Dublin
- Alistair Carson, Chief Science Advisor, DAERA
- Dr Donal Daly, President, International Association of Hydrogeologists, Ireland
- Mairead Glennon PGeo, President, Institute of Geologists of Ireland
- Angus Kerr, Chief Planner and Director of Regional Planning, Department for Infrastructure
- Dr Duygu Kiyan, Schrödinger Fellow, Dublin Institute of Advanced Studies
- Sam Knox, Business Development Executive and Technical Advisor, Invest NI
- Elaine Lennox, Education Manager (Chemistry), The Council for Curriculum, Examinations and Assessment
- Kaine Lynch, Deputy Director, Construction & Procurement Delivery, Department of Finance
- Craig McGuiken, Chief Executive Officer, Northern Ireland Environmental Link
- Professor Jennifer McKinley, School of Natural and Built Environment, Queens University Belfast
- Professor Julian Orford, Member, Council for Nature Conservation and the Countryside
- James Orr, Director, Friends of the Earth, Northern Ireland
- Dr Tracy Shimmield, Director, The Lyell Centre, Heriott Watt University
- Karen Smyth, Head of Policy and Governance, Northern Ireland Local Government Association
- Ken Stewart, Deputy Director, Ordnance Survey Northern Ireland
- Koen Verbruggen MRIA, Director Geological Survey of Ireland

Science Strategy Stakeholder engagement at Crumlin Road Gaol.

GSNI Science Strategy Development

The world has changed since GSNI was established in 1947; climate-change and the need for its mitigation and adaption combined with increasing population demands for low carbon energy, raw materials and water presents a series of challenges and opportunities for GSNI.

Subject to NI Executive approval, GSNI may have a role to play in contributing to the green economy by carrying out research and advising on low carbon energy and heat, surveying and monitoring the natural environment, involvement in a multi-disciplinary climate-challenge approach in NI, publishing data to protect human and animal health from geohazards, and informing sustainable tourism.

To help meet these societal challenges and opportunities, GSNI began the process of developing an inclusive and holistic Science Strategy to enable the organisation to augment, adapt and focus its current work programme to benefit every citizen in Northern Ireland.

Internal process

In the first half of the year GSNI ran a series of internal micro-workshops examining a range of strategy elements including shared organisational values, SWOT, PESTLE and stakeholder mapping. BGS supported this process by resourcing an externally-facilitated workshop led by Professor Donald McLean, Research Professor and consultant at the University of Glasgow. The two-day strategy workshop was held in Belfast in May examining our vison and mission and mapping out our business model. DfE officials were invited to give their perspectives during the workshop and informally in the evening.

External process

On 19th September 2019 we presented our initial thoughts on strategy themes and the process at the first meeting of our newly formed Science Advisory Committee (SAC). Feedback from the SAC members helped GSNI to frame the subsequent stakeholder survey and topics.

The stakeholder survey was carried out online between 15th January and 10th February 2020 through Survey Monkey and attracted 597 responses. The survey was promoted through GSNI social media channels and directly by email to GSNI stakeholders and users of our enquiry service. We asked questions on the following topics: Environmental Change and Hazard Resilience, Sustainable Resource Management and Decarbonisation, geological mapping and modelling, strategic partnerships, data, communications and education.

Stakeholder and public events

To complement the stakeholder survey and refine our thought-development process, GSNI carried out engagement activities to help steer and inform the content of the new Science Strategy. We ran two events for our stakeholders and the general public respectively at Crumlin Road Gaol in Belfast on Thursday 20th February 2020 as part of Northern Ireland Science Festival. The new Director of the British Geological Survey Dr Karen Hanghøj attended and presented at the stakeholder event which attracted 120 delegates. As part of this stakeholder event we summarised feedback from the online survey and hosted 10 thematic round-tables outlined on p30.

Next steps

GSNI will examine and summarise the stakeholder feedback from the themed round-table event; consolidate key strategy themes and begin the process of identifying outcomes, actions and measurable targets. Next FY we will bring our draft strategy back to the GSNI Science Advisory Committee and re-consult our stakeholders and the public.

Developing a sustainable economy

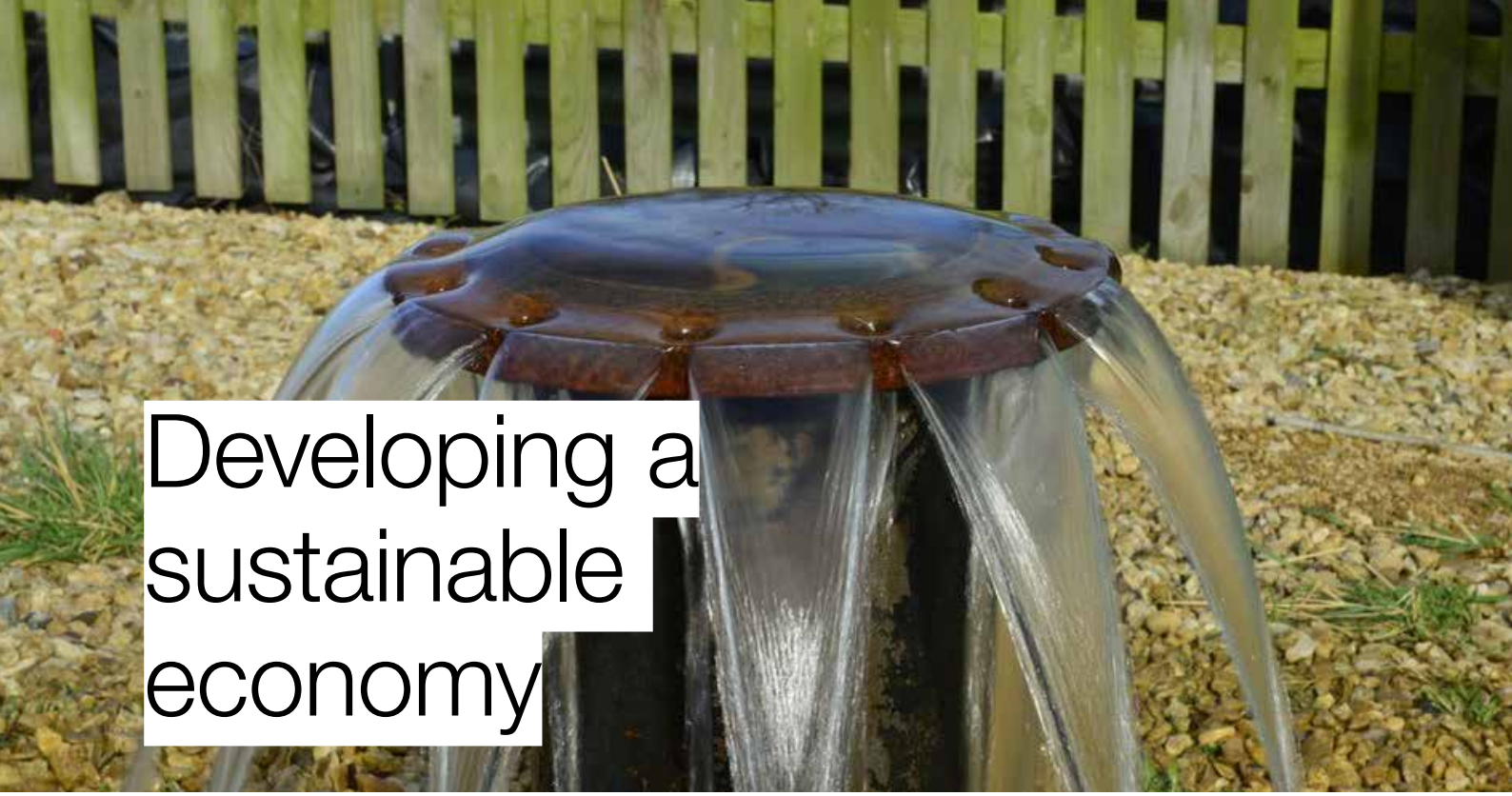
Clinty Quarry, near Ballymena, Co. Antrim.

Enhancement of Quarry Returns Information

In Northern Ireland, the 1969 Minerals Development Act vested all minerals in the local department responsible for economic development, with some exceptions. Extraction permission for hard-rock and unconsolidated sediments fall under planning powers, managed by the planning departments of the local district councils across Northern Ireland.

Under The Quarries (Northern Ireland) Order 1983, quarry operators across Northern Ireland are obliged to return yearly information on employment and production to the Minerals and Petroleum Branch of the Department. The key questions on employment, tonnage extracted and selling price of the raw material provide an ongoing reflection of the broader economic environment across the country. Up until recently, no information was gathered that demonstrated where Northern Ireland's aggregates were moving, either locally, across Northern Ireland or as exports.

In consultation with GSNI, new questions on sales were introduced and the most recent return provided enough detail to produce an indication of material movement for each of the Council regions. Though still not the full picture, the new information is being used to support the development of the Local Plan Strategies across Northern Ireland and support industry comments on mineral planning.



Developing a sustainable economy

Artesian groundwater borehole (Geoscenic P895148).

Groundwater Stakeholder Resources Group

In 2018, GSNI established a group to bring together anyone in Northern Ireland government and academia that has a role to play in groundwater resources. The group, formally known as the Groundwater Stakeholders Resources Group (GSRG), now meets twice a year preceded by some form of visit to a practical groundwater site. In October 2019, the group visited the shallow geothermal groundwater system that now cools the Biological Sciences building at Queen's University.

The aim of the group is to identify what gaps exist in the sustainable use and management of groundwater resources in Northern Ireland and to make proposals to the relevant government departments for progress towards more sustainable use of groundwater resources. These gaps include knowledge, educational, policy, regulatory, skills and awareness gaps. These outcomes will inform future work programmes for GSNI and its collaborators.

Underpinning infrastructure

Owenreagh windfarm, Strabane, Co. Londonderry.

Cross-Departmental Consultations

Knowledge of the subsurface and the vast array of information and data that GSNI holds means that we can provide a valuable contribution to the work of a variety of other government departments in addition to the Department. An understanding of the subsurface is important in terms of resources, infrastructure, environment and energy as well as playing a vital role in both mitigation and adaptation to climate change. This highlights the importance of GSNI's role within Northern Ireland government as well the cross-departmental multidisciplinary approach that needs taken to ensure the sustainability of Northern Ireland's future.

Over the past year, GSNI has responded to the DAERA Science Strategy Framework, the DAERA Environment Strategy for Northern Ireland, and more recently have worked on the response to the Belfast City Council Draft Belfast Resilience Strategy and the DAERA Green Growth Strategy.

One of the most significant pieces of work however has been the contribution of GSNI to the Call for Evidence for the Department's Energy Strategy. This marks the beginning of a process that will shape and inform an Energy Strategy for Northern Ireland that will enable new and challenging decarbonisation targets as the UK has committed to a 100% reduction in greenhouse gas emissions by 2050. GSNI's contribution to the Call for Evidence provides evidence of new opportunities for renewable energy, but also contributes to the energy transition discussion whilst still considering energy security. The contribution that GSNI has made will help to inform a new strategic direction for energy in Northern Ireland, looking at its impact on society as a whole and helping to make it more energy secure and climate resilient.

Underpinning infrastructure

Aerial view of Tennant Mine, near Carrickfergus, Co. Antrim.

Enquiry category	%
Abandoned Mines	65
Infrastructure	24
Quarries	4
Hydrogeology	2
Environment	2
Energy	1.5
Other Geohazards	1.5

Categories of enquiry responses in 2019-2020.

Planning office	%
Mid Ulster	31
Causeway Coast and Glens	28
Armagh City, Banbridge and Craigavon	13
Mid and East Antrim	12

Planning offices with the most consultations in 2019-2020.

GSNI's role in the development planning process

GSNI is a statutory consultee for development proposals, requiring planning permission for all mineral and hydrocarbon exploration or extraction applications. The circumstances in which we are consulted upon are set out in The Planning (General Development Procedure) Order (Northern Ireland) 2015 and The Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2015. GSNI is also a non-statutory consultee for development proposals that affected by underlying ground conditions including those within areas of abandoned mines.

In 2019/2020, GSNI responded to 176 development proposal consultations. The vast majority of these related to abandoned mines but consultations also related to hydrogeology, other geological hazards (such as subsidence) and quarries. GSNI responded to 85% of these within the required 21-day turnaround time, with the main reason for delayed responses being a lack of adequate information from the developers to assess the application.

In responding to development proposal consultations, GSNI plays a vital role in the local council planning process, driving forward economic development and ensuring due care and attention in areas that may pose a risk to public health.

Monitoring the environment

Groundwater monitoring as part of the CatchmentCARE project.

CatchmentCARE

CatchmentCARE (Community Actions for Resilient Eco-systems) is an EU-funded project that aims to improve freshwater quality in cross-border river basins across three cross-border catchments. The aims will be achieved through development of three water quality improvement projects in the Finn, Blackwater and Arney catchments and installation 50 groundwater monitoring boreholes across the region.

The project is being led by Donegal County Council and includes Armagh City, Banbridge & Craigavon Borough Council, working with academia in Ulster University, as well as the Agri-Food and Biosciences Institute, British Geological Survey (GSNI), Loughs Agency, Geological Survey Ireland (GSI) and Inland Fisheries Ireland. This broad range of knowledge and experience, brings added value to the project, further reinforcing the value of collaboration and working together for the good of not only the environment but also for local communities.

GSNI is working collaboratively with GSI on the groundwater monitoring borehole installation in Northern Ireland and in the adjacent counties in the Republic of Ireland. So far, a scoping study has focused on where the boreholes should be located to optimise their value for gathering long-term groundwater data. Contracts are being drawn up to allow for drilling, surface geophysics, groundwater sampling and monitoring, pumping tests and spring flow gauging.

Drilling will commence in 2020 beginning with the three sites in the Derg Catchment. This will be in support of another EU-funded project, Source 2 Tap, led by Northern Ireland Water.

Monitoring the environment

View over Garron Point and parts of the Garron Plateau, near Carnlough, Co. Antrim. © Tourism NI Media Library

Northern Ireland Coastal Forum Working Group

The Northern Ireland coastline has a natural geological foundation that defines its character and controls processes of erosion and deposition that shape it. In recognition of the significance of Northern Ireland's coastline and the importance of effective coastal management, Ministers from both DAERA and DfI established the Coastal Forum in 2015 to bring together relevant government departments, local councils and other interested parties to discuss coastal management issues and to consider if a strategic approach to tackling such issues could be adopted.

Two working groups were established, the Coastal Planning Working Group and the Coastal Forum Working Group, both of whom would feed into the overarching Coastal Forum. Given GSNI's knowledge of both the bedrock and superficial geology of the coastline and the processes that act upon them, we attended meetings of both working groups. One of the main outputs of those two working groups was the Position Paper to Inform Councils' consideration of Coastal Change when preparing Local Development Plans. This Paper recognises the difficulties that Councils face with respect to coastal management, many of which have arisen because of the absence of systematic collection of data to measure how the Northern Ireland coast is changing with time.

Because of this work, GSNI is now part of the Coastal Forum Working Group, which is the mechanism through which coastal management issues are being considered and progressed collaboratively by central and local government and the National Trust.

Enhancing tourism

View across to the Mourne Plain from Slieve Binnian, Mourne Mountains, Co. Down.
© Tourism NI Media Library

Mourne Gullion Strangford Aspiring UNESCO Global Geopark application
In 2017, Newry Mourne and Down District Council published its tourism strategy that identified the development of a UNESCO Global Geopark as one of its catalyst projects for the region. Since then, GSNI has been supporting the Council to bring this project to fruition and have delivered an extensive communication campaign, a comprehensive events and education programme, and carried out a site audit and development plan.

In 2019, together the Newry Mourne and Down District Council formally submitted an application dossier to UNESCO for the Mourne Gullion Strangford area to become a UNESCO Global Geopark. This included compiling a detailed application providing information on geological heritage and conservation, facilities and infrastructure, information, education and research, management, geotourism, sustainable development and partnership as well as the motivation for becoming a UNESCO Global Geopark. In addition, a number of supporting documents were compiled that included a large scale map of the region, letters of endorsement from key local stakeholders as well as from the UK National Commission for UNESCO, a self-evaluation document and a complete Earth science bibliography of the area,

If successful, the UNESCO Global Geopark will be a critical economic driver for the region helping to create jobs and diversify the rural economy, whilst still maintaining the integrity of the landscape and celebrating the local cultural heritage.

Enhancing tourism

View from the abandoned lead mines at Whitespots Country Park, near Newtownards, Co. Down.

Whitespots Country Park Tourism Development

GSNI have been working with Ards and North Down Borough Council to develop a visitor destination at the Whitespots Country Park just outside Newtownards. A former lead mining site, and one with exceptional mining heritage still preserved on site, Whitespots Country park has been identified as a potential project for the Belfast Regional City Deal and the Council has applied for funding to create a multi-use recreation and tourism destination.

The area has a wealth of history that encompasses not just the mining heritage but also World War I heritage. It is also a local recreation area with amazing views over Belfast and Strangford Loughs.

GSNI has been working with the Council to provide information on the location of abandoned mines as well as provide guidance on the tourism potential. This has involved numerous site visits and working group meetings with Council and Tourism NI representatives all of which have contributed to establishing the feasibility of the development and has led to the Whitespots Masterplan that was formally approved by the Council in March.

GSNI now sits on the Whitespots Leadership Group which is currently developing the Outline Business Case for the site whilst the Strategic Case has just been presented to the Belfast Region City Deal Tourism & Regeneration Advisory Board outlining why investment is required for the project.

Protecting human and animal health

Basalt scree slopes at the Giant's Causeway, Co. Antrim.

Platform for Atlantic Geohazard Risk Management (AGEO)

The Platform for Atlantic Geohazards Risk Management (AGEO) is funded under the Interreg VB Atlantic Area programme and is for a total of €2.5 million between 2019 and 2022. AGEO is being led by the University of Lisbon and GSNI are one of 12 partners involved in the project that will see the launch of seven Citizens' Observatories across France, Portugal, Spain, Ireland and UK. The aim is to encourage local communities to actively participate in geohazard monitoring, and to enhance local capacity in risk management.

GSNI have identified key coastal geological tourist sites in Northern Ireland that are impacted by landslides and are setting up an observatory. GSNI are working closely with stakeholders to outline the purpose of the observatory and are delivering a programme of public engagement and education that will ensure its effectiveness.

In addition to the Citizens' Observatories, the project aims to encourage regional-level uptake and use of products and services provided by the European earth observation satellite service Copernicus. The first steps taken was to conduct a survey on stakeholders' knowledge of earth observation monitoring and how they thought it could benefit management of their site. The results of this survey provided the project with the valuable information needed to carry out exploratory work to integrate earth observation data most effectively to the pilot sites. The goal is to incorporate the use of this into the Citizens' Observatories to ensure that effective risk management for geohazards can be developed.

Protecting human and animal health

Abandoned iron mine collapse at Parkmore, near Glenariff, Co. Antrim.

Emergency Response Plan: Incorporating mine rescue capability

GSNI have continued to work closely with the emergency services, Department of Justice and other stakeholders on the Northern Ireland Abandoned Mine Emergency Response Plan. The plan puts in place the multi-agency process and procedures in the event of an incident at any of Northern Ireland's 2,400 abandoned mine workings. Throughout the year GSNI have continued to coordinate regular meetings with all key stakeholders as well as updating risk assessment information packs.

Over the past 12 months the emergency response plan has incorporated underground mine rescue provision in the event of a person trapped within a disused mine. This has greatly enhanced the capacity of the Emergency Response Plan (ERP) as it puts in place cover to carry out underground rescues in the event of a person trapped within a disused mine. This service will be carried out by MRS Training & Rescue, a global operating specialist rescue service with over 100 years of experience of working and carrying rescues in dangerous underground environments. Joining the scheme has been a significant development in ensuring public safety in the event of any incident associated with an abandoned mine. As well as GSNI responders, MRS will also provide a 24/7 call out service if such an incident occurs.

The past twelve months have also seen the ERP being reviewed and updated to incorporate the addition of MRS Training & Services and to take account of extra precautions required during the coronavirus pandemic. GSNI will continue to work closely with the numerous agencies and stakeholders to ensure the NI public are safe.

Supporting education

Triassic-Jurassic boundary seen in rock core at GSNI's Core Store.

Transformation of GSNI's core store

The GSNI core archive constitutes a valuable resource for Northern Ireland. Housed on the outskirts of Belfast, the suite of rock cores, geochemical and geological samples from across Northern Ireland have undergone conservation work to enhance and preserve them, thereby enabling the samples to be accessed more easily. Some of the cores date back to just after the inception of the survey in 1947 as a result of Northern Ireland's requirements for gypsum, coal and perlite. The core store is the official repository for all petroleum exploration borehole material and samples are held from major survey projects, such as the Tellus survey or from important infrastructure projects such as the Slieve Binnian Tunnel constructed in the Mournes between 1947 and 52.

At the same time as the remedial work on the collections, research has been encouraged to add value to the archive. In 2019/2020 much of this initial research is starting to come to fruition. Some of the research on the GSNI core archive forms part of a larger collaborative study of the Triassic-Jurassic boundary and the GSNI holds cores across this important stratigraphical boundary that have been sampled extensively by researchers. At least 180 biostratigraphy samples, 320 geochemical samples and 54 palynology samples have been analysed and over 320 fossil samples collected. In 2019/2020 two peer-reviewed papers were published that used GSNI core archive data and five papers were in review or in press. The archive has contributed material for one undergraduate project, six post-graduate and two post-doctoral research projects.

Supporting education

Geography pupils learning about GIS at Lurgan College.

CCEA Geography Subject Advisory Group

Studying geography at post-primary school is one of the few ways that young people are exposed to geoscience and offers valuable encouragement for many students who then go on to study geology at a higher level. The value of geography as key conduit for geoscience is emphasised even further as the NI Skills Barometer compiled by the University of Ulster has identified an under supply of skills in the physical and environmental sciences sector in both the short and long term.

Given the skills gaps identified above, GSNI was delighted to be asked to sit on the Geography Subject Advisory Group by the Council for Curriculum Examination and Assessment (CCEA), to help shape and inform the future development of the geography curriculum for our post-primary schools.

The advisory group is made up of representatives from post-primary schools from a range of geographical and cultural areas in Northern Ireland. In addition, there are representatives from both the University of Ulster and Queen's University Belfast, Southern Regional College (the only Further Education college in Northern Ireland currently offering geography), the Tollymore National Outdoor Centre, and the Magilligan Field Studies Centre.

One meeting took place in 2019/2020 when the progression of geography through the post-primary curriculum was discussed, and how to ensure suitable progression pathways are in place to encourage retention of students, as well as the lack of provision for GIS within Northern Ireland schools and what could be done to address these.

Working towards a sustainable future

Coastal defences at Ballyhornan beach, near Strangford, Co. Down.

Cross-Departmental Working Groups

The 2019/2020 financial year saw an important new development in the work of GSNI with the invitation to take part in a number of significant cross-departmental working groups. This shows recognition for the value and importance of the work done by GSNI and the substantial contribution that GSNI can make to a range of issues including energy, infrastructure and the environment.

Many of these cross-departmental working groups have been established to address the potential impacts and effects of climate change and show a real positive deviation towards multidisciplinary approaches to solve complex issues.

Some of the working groups that GSNI are now represented on include the DAERA-led Climate Change Adaptation Sub-Group, the DAERA-led Climate Change Mitigation Sub-Group, the DAERA-led Future Generations Working Group, the DfE led Heat Policy Working Group and the previously mentioned joint DAERA and DfI led Northern Ireland Coastal Forum Working Group.

How we performed

Governance

Under the Minerals (Miscellaneous Provisions) Act (Northern Ireland) 1959, a recurrent three-year Service Level Agreement (SLA) to undertake a research programme exists between the Department for the Economy (DfE), Northern Ireland and the UK Research Institute (UKRI) represented by the BGS and carried out by the GSNI. The GSNI Director reports monthly, quarterly and annually to the DfE on the delivery of this research programme. The governance of GSNI and the performance of its work programme is also audited and reviewed as required by DfE. In addition, as a science Director at BGS, the GSNI Director reports to the BGS Executive.

Working Procedures (Procedures Manual)

All aspects of GSNI governance is detailed in its Procedures Manual, an internal organisational document, which is updated as required, reviewed and signed by all staff annually and is also audited cyclically by DfE.

Date	Ammendment/Additions
10/04/19	Amendment to obtaining permission for use of vehicles for non-SLA fieldwork Updated Organogram
15/04/19	Notification of absences / sick leave
05/06/19	Use of portable XRF
13/08/19	Menopause Guidance
08/10/19	Amendment to i-Expenses procedure
January 2020	Amendment to Procedures Manual layout

Health & Safety

- There was one accident, no incidents and no near misses. 17 Risk Assessments were completed.
- GSNI's Automated External Defibrillator (AED) provided by BGS has now been registered with the Northern Ireland Ambulance Service on their database.

- Wellbeing has been high on the agenda in GSNI and an integral part of health and safety with all staff completing Wellness Action Plans as part of their annual appraisal.
- A visit from the UKRI Welfare Officer was organised to bring to the attention of all staff the support mechanism available should they need it.
- GSNI has revised its lone worker policy for those going into the field and re-adjustments to working from home.

Energy, Minerals and Waste		
Objective No.	**Objective**	**Targets Achieved in 19/20**
1	To support the regulatory and administrative functions of DfE MAPB for mineral exploration development and enhance the knowledge and understanding surrounding mineral resources in NI	Yes
2	To support the regulatory and administrative functions of DfE MAPB for petroleum exploration and development and enhance the knowledge and understanding surrounding oil and gas, and geothermal resources in NI	Yes
3	To develop professional capacity within GSNI, provide technical information and advice on natural resources in NI, and carry out geological and geophysical monitoring to establish baseline parameters across NI in support of energy and economic infrastructure development	Yes

Information and Infrastructure		
Objective No.	**Objective**	**Targets Achieved in 19/20**
1	Provide DfE with advice on abandoned mines and reduce the associated risks	Yes
2	Increase the awareness of geological hazards and their impact on the NI economy	Yes
3	Provide advice and data to a diverse range of stakeholders and customers to underpin and support DfE	Yes
4	Realise the full potential of geological tourism and the benefit that it has for the NI economy	Yes
5	Deliver a set of free environmental data and information in the context of hazard mitigation and adaptation, environmental management etc.	Yes

Geology and Groundwater		
Objective No.	**Objective**	**Targets Achieved in 19/20**
1	Undertake baseline geological survey of prescribed areas of NI and provide digital outputs to support DfE and stakeholder functions	Yes
2	Produce thematic geological maps and supporting data for specific stakeholder groups	Not progressed in current SLA
3	Advance 3D geological models and their uptake by stakeholders at national and city scales to allow visualisation and assessment of the subsurface volume	Yes
4	Identify and undertake collaborative, high impact research and funding bids to support DfE and stakeholder needs	Yes
5	Develop a better understanding and assessment of groundwater as an economic resources	Yes

Type	Qty	Description
Papers	5	Peer-reviewed publications
Reports	6	Internal and external reports
Enquiries	626	Requests for information dealt with through the enquiry system
Responses to planning consultations	176	Responses to consultations via the NI Planning Portal

Data and facilities

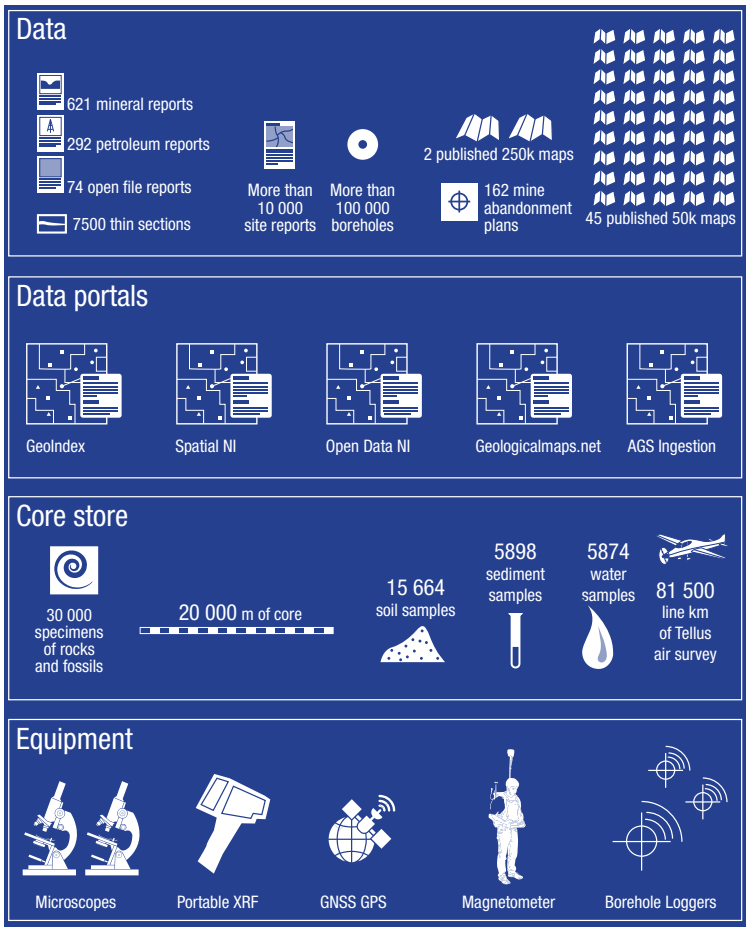
GSNI data is published on a number of platforms including GeoIndex, Spatial NI (**spatialni.gov.uk)** and Open Data NI (**opendatani.gov.uk)**.

AGS data ingestion

Deposits of AGS data from ground investigation works began through the Pan Government Framework. These form a long term archive of digital data that are made available for re-use under the Open Government Licence.

GSNI core store

GSNI manages Northern Ireland's core store and sample repository which currently holds over 20 km of rock core from boreholes, approximately 30,000 rock samples collected during geological mapping and geochemical samples from the Tellus surveys. In 2019–2020 it received 109 visitors including a fully booked event as part of the NI Science Festival. The core archive was furthermore used as a teaching resource with core workshops held for the University of Birmingham and visits for research on the cores from doctoral and post-doctoral researchers and industry appointments.



Improved petrographic analysis capability

GSNI, through a BGS capital bid, updated its petrographic analysis capability with the purchase of new Olympus polarizing microscope and that will be used to analyse sandstone reservoirs in the assessment of geothermal resources in NI and make full use of the archive of over 6000 petrographic slides that GSNI curates.

Our staff

Learning and development

Learning and Development (L&D) is primarily managed by the L&D team at BGS who provide and support training in leadership and management, behavioural / soft skills, IT, science, Health and Safety, bespoke coaching, mentoring and other training opportunities as they arise.

All staff carried out mandatory training on the following:

- Cyber Safety (UKRI)
- Fire Safety (NICS)
- Information Handling (NICS)
- Modern Slavery (UKRI)

In addition, L&D courses were delivered under a number of themes to GSNI staff throughout the year:

Continuing Professional Development

Course Type	No. Courses	Total no. of courses delivered
Leadership and Management	2	2
Behavioural / Soft Skills	5	8
Technical	5	13
Health and Safety	3	9
Bespoke Coaching	1	1

Continuing Professional Development is encouraged and supported at all levels. The CPD highlights for 2019-2020 are as follows:

- One staff member was awarded the Institute of Directors (IoD) Diploma in Company Direction.
- One staff member was elected a Member of the Royal Irish Academy.
- One staff member has undertaken the Copernicus Massive Open Online Course (MOOC), developed by the University of Luxembourg and PwC for the European Commission.
- One staff member is currently undertaking a MSc in Climate Change and

Development with the University of London.

- One staff member has been awarded a place on the Boardroom Apprentice programme with the Armagh Observatory and Planetarium as their host board.
- Three staff members are working towards Chartership and/or PGeo from either the Geological Society of London or the Institute of Geologists of Ireland.

Our clients and collaborators

Clients

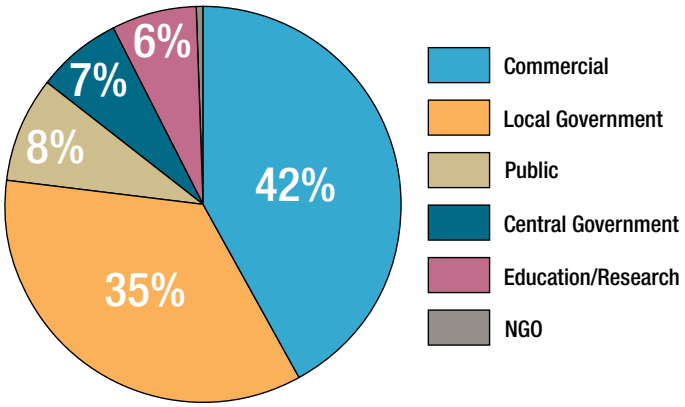
GSNI responded to **626** enquiries. The sector represented and enquiry type have been collated from the enquiries database and are shown in the charts below.

2019-2020

626

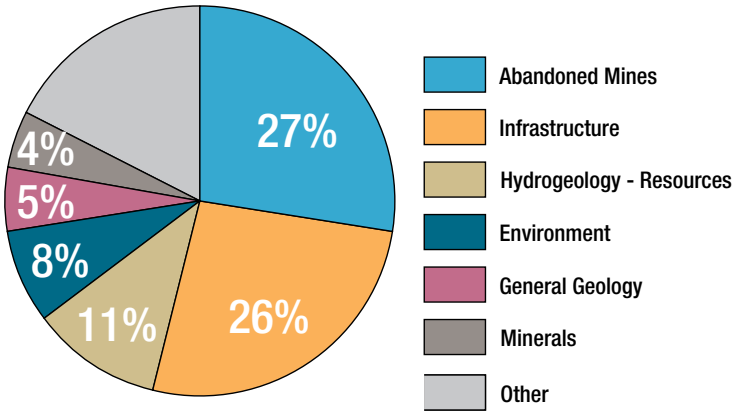
ENQUIRIES

Sector



Category

Enquiry category	%
Abandoned Mines	27
Infrastructure	26
Hydrogeology	11
Environment	8
General Geology	5
Minerals	4
Other	19



Categories of enquiry responses in 2019-2020.

Collaborations

GSNI collaborates with numerous stakeholders to deliver a number of strategic objectives. A list of the main collaborations is provided below:

Stakeholder Type	Stakeholder	Description
International	GSI, EMD, InvestNI, Geoscience Ireland, Enterprise Ireland	Support the Department for the Economy in maintaining the profile of the Northern Ireland minerals industry on a global stage at PDAC, Toronto.
	UNESCO	Work with the UNESCO Global Geoparks council and UNESCO Secretriat to maintain and develop UNESCO Global Geoparks internationally and to raise profile of NI.
	North-East Atlantic Geological Surveys	Partnership of of 10 Geological Surveys within the Northeast Atlantic area exploring geological themes where there is a significant overlap in interest.
	Royal Irish Academy	Geosciences and Geographical Sciences Committee
	BGS, GSI and GSNI Directors	Memorandum of Understanding between three geological surveys in the UK and Ireland
Research	Leeds University	Ongoing visits from staff and students and the development of research projects on ore deposits in NI
	Queen's University, Belfast	GSNI and BGS led brownfield workshop at the QUB Remediate Conference
	iCRAG	Member of the iCRAG Governance Board
	INQUA	Organisation of 2019 INQUA Congress and Associated Outreach and Fieldtrips
Central Government	DfI	Leading on the development of the Minerals Working Group
	DoJ / Emergency Services	Liaise with DoJ, emergency services and local resilience groups to maintain the Abandoned Mine Emergency Response Plan
	DAERA/NIWater	Leading on the development of the Groundwater Working Group
	DfE/DfI	Representation on UK Minerals Forum together with GB government, industry, professional bodies and NGOs
	All, Strategic Planning Group	Ensure that GSNI interests are well considered as part of the POPs and LDP process

GSNI currently has responsibility for research supervision in collaboration with the following Universities

Institution	Description
Birmingham University	PhD (Stratigraphy and emplacement of the Antrim Lava Group)
	MSci (Magnetic fabrics and remnant magnetism of the Fair Head Sill. Co. Antrim)
Leeds University	PhD (Structural controls of orogenic gold in Northern Ireland)
Queen's University, Belfast	PhD (The impact of thermal plumes on aquifer properties and groundwater quality)
	MSc in Sustainable Leadership (Geothermal heating systems)
	MSc Environmental Engineering (Rathlin Island groundwater supply)
	MSc Environmental Planning (Sustainable tourism in Mourne Gullion and Strangford
Ulster University	PhD (Decision-support tool for farmers)
University College London	MSc

Potential Future Collaborations

A number of discussions have taken place with stakeholders in 2020/2021 that are likely to lead to key collaborations with GSNI. A list of these potential future collaborations is provided below:

Stakeholder Type	Stakeholder	Description
Research	QUB	Exploring the possibility of developing geological mapping using machine learning
Research	QUB, Aberdeen	Installation of new QUADRAT till properties PhD
Research	BGS, DfE, DIAS	Space Weather and and Natural Seismic Monitoring Station installation
Research	Li4UK	Research project (funded by Innovate UK Industrial Strategy Challenge Fund) assessing UK lithium potential within the UK to ensure UK supply for electric vehicles.
Central Government	DfI / DAERA	Assessment of NI Coastal Vunerability and adaptation to climate change. Group includes DfI, DAERA and representatives from local councils.
Central Government	Housing Executive	Exploring the potential of developing the shallow geothermal potential for local councils
Central Government	Coal Authority	Potential collaboration on shared knowledge on managing abandoned coal mine sites including public and environmental impact

Our engagement

GSNI Stakeholder Survey & Event

Stakeholder discussions at the GSNI Stakeholder Engagement event at Crumlin Road Gaol.

To inform the development of GSNI's new Science Strategy a series of activities and events were organised to help inform this process. The first of these was a GSNI Stakeholder Survey designed to identify key priorities based on two overarching strategic themes:

- Environmental Change & Natural Hazard Resilience
- Sustainable Resource Management & Decarbonisation

The survey was made available online and was open to the general public as well as to targeted stakeholders from key sectors including government, industry and academia.

In total, there were 597 responses, with 461 completing the entire survey. The greatest number of respondents were from government (35%), but there was also strong representation from the private sector (19%), general public (14%), and research (13%).

To complement the GSNI Stakeholder Survey, a Stakeholder Engagement Event was held in Crumlin Road Gaol to coincide with the Northern Ireland Science Festival (NISF). This event presented the preliminary results of the survey and provided a forum to further discuss the following key priorities:

- Geological mapping
- Groundwater
- 3D modelling
- Geohazards
- Education
- Tourism
- Raw materials
- Energy resources
- Coast and marine

Over 120 stakeholders representing all sectors attended the event that included keynote talks from the Director of the British Geological Survey, Dr Karen Hanghøj on the benefits of a circular economy and of the Geological Survey Ireland, Koen Verbruggen on the importance of strategic partnerships.
The feedback from the stakeholder engagement event, together with the results from the stakeholder survey will directly inform the new GSNI Science Strategy.

INQUA Congress

The International Union for Quaternary Research (INQUA) congress, held every four years, took place in Dublin, July 2019. GSNI were part of the local organising committee since 2014, and involved with promoting and organising the congress as well as securing sponsorship.

Participants at the INQUA Congress fieldtrip to the Mourne Mountains led by GSNI.

Combined with staff from the BGS we were involved with running and participating in over 27 scientific sessions during the congress across a huge range of topics. GSNI attended a meeting at the GSI on the International Quaternary Map for Europe where and we are now a UK representative.

GSNI sponsored an expo stand at INQUA, which allowed the All Ireland Quaternary Map to be included in every delegate conference pack. GSNI also had a 1000 piece jigsaw of the All Ireland Quaternary map on the stand. This attracted many puzzle aficionados and a Twitter competition was run to win a copy and help to promote the GSNI brand. The display copy was also donated to the Irish Quaternary Association.

GSNI staff also ran a one-day field trip to the internationally renowned Kilkeel steps in Co. Down, as well as a three-day field trip that also included excursions into the Mourne mountains, Killard Point and Ballynahinch. The sites proved to be an excellent ground for discussion and ideas for further work and collaboration.

Climate Change Challenge

The Northern Ireland Science Festival (NISF) takes place over a two-week period in February every year with over 200 events in more than 50 venues all across Northern Ireland. The aim of the festival is to raise awareness of STEM and in many cases, this is done in as creative and exciting a way as possible.

For NISF 2020 GSNI organised the Climate Change Challenge at the GSNI Core Store. The event provided an opportunity to explain how geologists can provide valuable insight into past climate change and to encourage all those that attended to use their newly found knowledge to try to decipher a past climate from the clues provided.

The Climate Change Challenge event at GSNI's core store as part of the NI Science Festival.

With interactive activities that involved micropalaeontology, geochemistry, palaeontology, palynology and rock types it gave the general public the chance to explore Northern Ireland's diverse climate history and how this relate to present and future climate change.

The Climate Change Challenge was completely booked out and was attended by over 60 people that ranged in age from 7 to 70 years old. Event evaluation forms indicated a 100% very good or excellent rating and all of those that attended asked to see more similar events.

Lectures and Talks

8 fieldtrips led for external stakeholders
7 lectures / talks as invited speaker

Education Events

Event	Level	No. of Schools	No. of attendees
Fossil Forage at Cranfield	Primary	4	c. 80
Science Week School Workshops	Primary	12	c. 360
Grosvenor Grammar Careers Day	Post Primary	1	c. 200
Belfast Hills STEM EXPO	Post Primary	2	c. 180

Digital Communications

Twitter followers increased by 15%
Facebook followers increase by 18%
Total impressions 455.1k
Total reach 87.4k

Finance

2019-2020FY Projects	Amounts	%
NI Public Service Level Agreements	£747,772.18	80%
Additional Research	£71,972.76	8%
BGS External Income	£20,293.26	2%
BGS (UKRI)	£50,446.61	5%
Personal Development (UKRI)	£47,982.54	5%
	£938,467.35	

Northern Ireland Public Science
GSNI predominantly provides public science research services to government departments and NI councils, primarily for DfE as part of its three-year recurrent work programme managed under a service level agreement (SLA), for DAERA under an annual SLA, and for Newry, Mourne and Down District Council (NMDDC) on its UNESCO Global Geopark bid.

Additional Research
GSNI also has funding from UK Research and Innovation (UKRI) via BGS and EU programmes. GSNI-based staff work on BGS Teams (UKRI) either on external research or internal 'national-capability' or operational projects.

Professional Development
As GSNI staff are UKRI employees, BGS (UKRI) pays for their continuing professional development (CPD), mandatory training including health and safety.

Sales
The majority of GSNI's data is free and openly accessible online but for analogue data, or data that needs to be retrieved, we charge for staff time and together with book and maps sales this accounts for an annual income of £20k pa.

View from the Cuilcagh Mountain Boardwalk, Marble Arch Caves UNESCO Global Geopark, Co. Fermanagh

Forward look

Coronavirus disease (COVID19)
On 31 December 2019 news emerged from Wuhan, China that a novel respiratory virus had been identified. From Jan 10-12th the World Health Organisation (WHO) published guidance documents for national governments and on 31 January WHO declared the novel coronavirus outbreak a public health emergency of international concern (PHEIC), WHO's highest level of alarm. The GSNI Director and staff monitored these events as the virus travelled west into Italy and updated their Business Continuity plan in February. On Friday March 13th all GSNI met together in the office for the last time to make final arrangements for remote working before they all began working from home on Monday 16th March.

SLA work programme 2020/21FY
In Q4 2019/2020FY, DfE agreed a one-year addendum to the current three year service level agreement between UKRI (BGS) and DfE and signed off a new GSNI work programme for the 2020/2021 financial year. This programme will run parallel to DfE's planned reviews of petroleum and minerals licensing and the development of it's new Energy Strategy for Northern Ireland.

The new work programme will focus on the Energy transition and Green Growth; looking at the potential for geothermal energy potential in for Northern Ireland and the scoping of a large infrastructure project. Also planned is a desk-top review of the potential for Critical Raw Materials in Northern Ireland.

GSNI will also review the opportunities presented by accessing, processing and interpreting satellite and terrestrial earth observation data and the potential applications to mine subsidence, landslides and coastal vulnerability. GSNI will also explore the possibility of coastal and sea-bed mapping survey(s) as part of a DAERA project in development.

Work will continue on the €12M EU-funded Catchment Care project in collaboration with BGS, the Geological Survey of Ireland and Agri-Food and Biosciences Institute with bore well drilling and catchment monitoring in selected cross-border catchments.

GSNI will map out the themes of its strategy, identify outcomes, actions and measurable targets before bringing a draft to seek feedback from our Science Advisory Committee, stakeholders and civic society.

Climate Change and Sustainability

Northern Ireland is facing an unprecedented time of environmental change in terms of climate. Rising seasonal temperatures, increased frequency of heatwaves, rising sea levels, changes in rainfall patterns and increased intensity and frequency of storms are just some of the projected impacts of climate change. Coupled with population growth and increasing development, a wide range of shocks and stressors will be placed on both our environment and natural resources.

GSNI has a huge role to play in helping to mitigate and adapt to these changes with an understanding of the subsurface a key part in working towards a climate-resilient Northern Ireland and supporting sustainable development.

Many of these issues will be included in our new Strategy highlighted in the two main science themes of Environmental Change & Geological Hazards and Sustainable Resource Management. However, addressing the many impacts of climate change on our environment and natural resources requires collective action and needs to be truly multidisciplinary.

Over the coming years we will therefore continue to develop and strengthen our participation in cross-departmental working groups and avail of opportunities to contribute to relevant plans and strategies across all sectors. Much of this work has already begun with significant contributions to a number of key strategy consultations this year for energy and agriculture as discussed earlier. We are also working with Belfast City Council by contributing to the Belfast Resilience Strategy and are seeking to develop a dataset for coastal vulnerability to help local planners assess the risk of coastal erosion. By working collectively, we will help to ensure that climate-resilience and vulnerability reduction become a core element of sustainable development at both a local and central government level.

Geothermal

GSNI along with counterparts in GSI is currently working on a proposal to look at the potential for using geothermal energy in Northern Ireland and Ireland. Funding will be sought from the PEACE Plus cross-border programme from 2021 until 2027.

The project will allow for a practical demonstration of deep geothermal energy potential and the application of heat networks using shallow geothermal energy and ground source heat pumps. Geothermal energy can provide consistent, sustainable low carbon energy, especially for heating and cooling, which is cost-effective over long periods, demonstrated in many European countries.

Deep geothermal energy resources (commonly 2-3 km deep) are characterised by high temperatures suitable for providing direct heat-to-heat networks or producing combined heat and power, if hot enough. Shallow geothermal energy (up to 400 m deep) is a highly efficient, low carbon heat source for heat pumps, providing stable heat throughout the year.

In recent decades, improvements in geothermal technologies, coupled with supportive policies, has led to the development of geothermal district heating in other parts of the Europe. The proposed project will seek to grow and support a similar geothermal industry in Northern Ireland, increase public awareness and understanding of geothermal as a source of energy and produce a policy framework for developing our native geothermal resources.

Publications

GSNI produces numerous publications each year in the form of peer-reviewed papers, reports, conference abstracts, magazine articles, and various online publications. A list of all those produced in 2019/2020 are listed below:

Scientific Papers

Fyfe, L-J, C., Schofield, N., Holford, S.P., Heafford, A., **Raine., R**. 2020. Geology and petroleum prospectivity of the Larne and Portpatrick basins, North Channel, offshore SW Scotland and Northern Ireland. Petroleum Geoscience, 26, 272-302.

Franklin, J., Tyrrell, S., O'Sullivan, G., Nauton-Fourteu, M., **Raine, R.** 2020. Provenance of Triassic sandstones in the basins of Northern Ireland—Implications for NW European Triassic palaeodrainage. Geological Journal, 55.

Lemon, K. & O'Neill, M. 2019. Rockin' Around the Marble Arch Canes UNESCO Global Geopark. Marble Arch Caves UNESCO Global Geopark.

O Dochartaigh, B.E., MacDonald, A.M., Black, A.R., Everest, J., **Wilson, P.**, Darling, W.G., Jones, L., & Raines, M. 2019. Groundwater - meltwater interaction in proglacial aquifers. Hydrology and Earth System Sciences, 23. 4527-4539. https://doi.org/10.5194/hess-23-4527-2019

Raine, R.J., Copestake, P., Simms, M.J., Boomer, I. In press. Uppermost Triassic to Lower Jurassic sediments of the island of Ireland and its surrounding basins. Proceedings of the Geologists' Association.

Published Reports

Lemon, K and Sigursveinsson, S. 2019. Revalidation mission report for the Langkawi UNESCO Global Geopark, Malaysia. UNESCO.

Wilson, P. 2020. Bann Estuary and Magilligan Umbra Groundwater Monitoring Studies Interim report 2020. GSNI report for the NIEA

Lemon, K., **Parker, K.** & **Donald, A.** 2019. Planning guidance.

Lemon, K., **Donald, A.** & **Raine, R.** 2019. Application dossier for the Mourne

Gullion Strangford Aspiring UNESCO Global Geopark.

Everett, P.A.; Lister, T.R.; Fordyce, F.M.; Ferreira, A.M.P.J.; **Donald, A.W.**; Gowing, C.J.B.; Lawley, R.S.. 2019 Stream sediment geochemical atlas of the United Kingdom. Keyworth, Nottingham, British Geological Survey, 94pp. (OR/18/048)

Raine, R.; **Reay, D.M.**. 2019 A review of geothermal reservoir properties of Triassic, Permian and Carboniferous sandstones in Northern Ireland. Belfast, UK, Geological Survey of Northern Ireland, 59pp. (INTERNAL REPORT 19/EM/01) (Unpublished).

Conference Abstracts

Cooper, M. 2020. Mapping and Structural Geology of the Lower Palaeozoic Longford-Down extension of the Southern Upland terrain in Northern Ireland. Tectonic Studies Group, 7th to 9th January, Hull.

Cooper, M., Tapster, S. & Condon, D. 2020. Feeling the pulse? New high resolution U-Pb zircon geochronological constraints for the Northern Ireland sector of the North Atlantic Igneous Province. EGU General Assembly Conference Abstracts 2020-8464.

Hughes, L., **Roberson, S**. & **Donald, A.** 2019. The application of high-resolution structure-from-motion photogrammetry and digital field-mapping systems to interpret glaciated landsystems in the Keady region, Northern Ireland. 20th Congress of the International Union for Quaternary Research (INQUA), 25th to 31st July, Dublin, Ireland.

Lemon, K., **Parker, K.** & Holohan, E. 2020. The Platform for Atlantic Geohazard Risk Management: using Citizens Observatories to monitor geohazards in Ireland. 63rd Irish Geological Research Meeting, 28th February to 1st March, Athlone.

Raine, R., **Reay, D.**, **Wilson, P.** & Millar, R. 2020. The Sherwood Sandstone Group as a potential geothermal aquifer across Northern Ireland. 63rd Irish Geological Research Meeting, 28th February to 1st March, Athlone.

Ortega Rodriguez, A., Carrilho Gomes, R., Tekmo Jeremias, F., Santamarta, J., Quental, L., I., Galindo Jiménez, Correia, V., Narciso Pinto, C., Le Dantec, N., Gouveia, F, **Lemon, K.,** A., Hénaff & O'Hare, G. 2020. AGEO – Natural hazard prevention and awareness raising through citizen observatories. EGU General Assembly Conference Abstracts 2020-13519.

Patton, M. 2019. Issues in securing access to critical minerals; experience from Northern Ireland. 3rd International Critical Metals Conference, 20th April to 2nd May, Edinburgh.

Pellicer, X., **Roberson, S.** & Sheehy, M. 2020. The development of an All-Ireland Quaternary Map. 20th Congress of the International Union for Quaternary Research (INQUA), 25th to 31st July, Dublin, Ireland.

McKinley, J. & **Parker, K.** 2019. Monitoring of ground stability using spatial data analysis from satellite interferometric snytheitc aperture (INSAR) and UAV acquisition. Internatioanl Conference of Silk Road Disaster Risk Reduction and Sustainable Development (SiDRR), 11th May, Beijing, China.

Warke, M., Pettigrew, R., Millward, D., **Raine, R.**, Clarke, S., Peng, Y. Bao, H. & Claire, M. 2020. Spatiotemporal δ17O variability in the rock record. EGU General Assembly Conference Abstracts 2020-5752.

Ortega Rodriguez, A., Carrilho Gomes, R., Tekmo Jeremias, F., Santamarta, J., Quental, L., I., Galindo Jiménez, Correia, V., Narciso Pinto, C., Le Dantec, N., Gouveia, F, **Lemon, K.**, A., Hénaff & O'Hare, G. 2020. AGEO – Natural hazard prevention and awareness raising through citizen observatories. EGU General Assembly Conference Abstracts 2020-13519.

Patton, M. 2019. Issues in securing access to critical minerals; experience from Northern Ireland. 3rd International Critical Metals Conference, 20th April to 2nd May, Edinburgh.

Platform Articles

Donald, A.W. 2019. Resources for infrastructure. Agenda NI, June 2019.

Cowan, M. T. 2019 Geoscience industry and the economy. Agenda NI, October 2019

Lemon, K. 2019. Planning for the future: consulting with the Geological Survey of Northern Ireland. Agenda NI, December 2019.

Blogs

Lemon, K. 2019. Northern Ireland – Made for Golf but Made by Geology. Geoblogy July 2019.

Strategic partners

The beach at White Rocks, Co. Antrim

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