DEPARTMENT OF COMMUNICATIONS, ENERGY AND NATURAL RESOURCES

Post-project evaluation of the Tellus Border project

6 June 2014

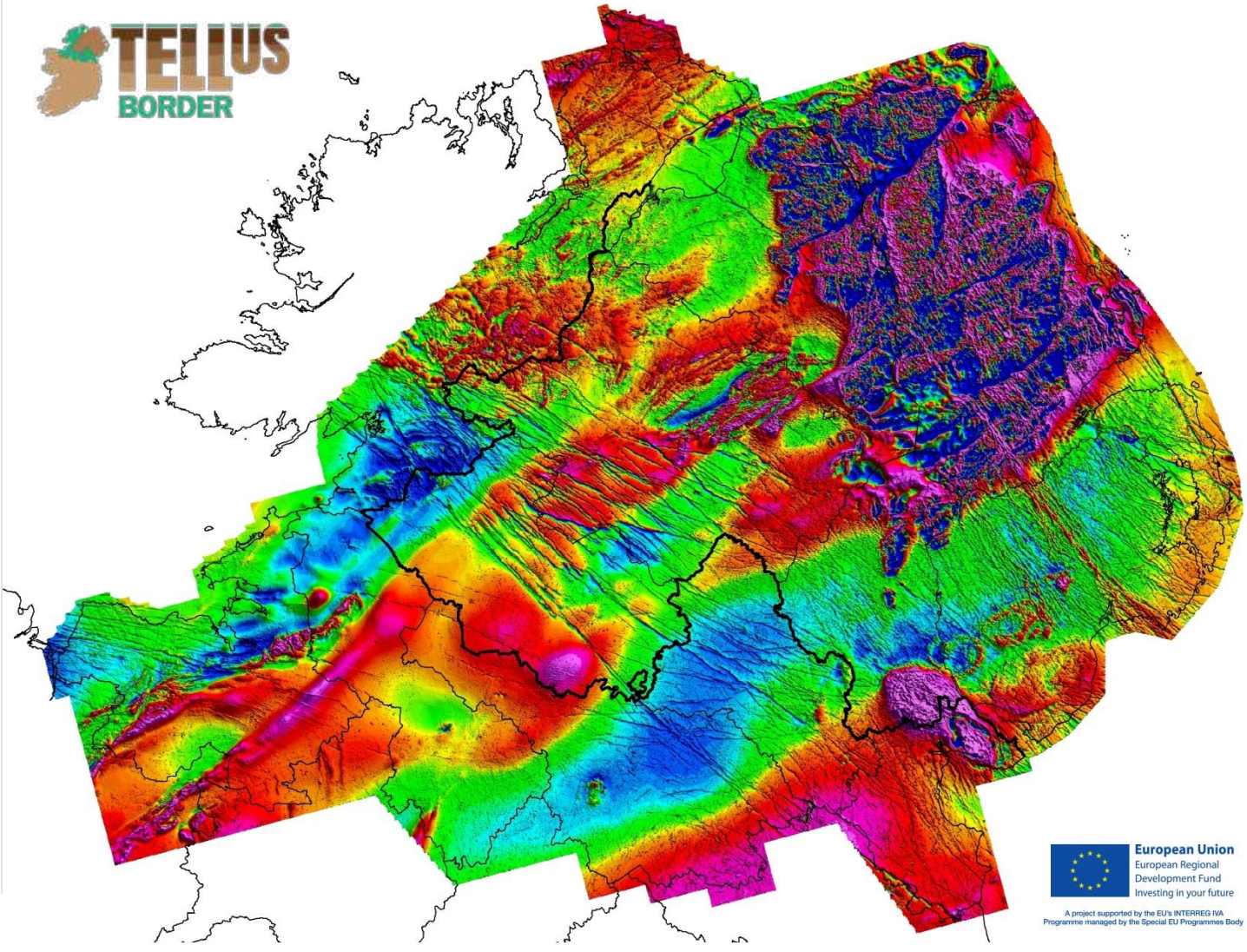

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TABLE OF CONTENTS

The front cover shows a representation of the cross-border magnetic anomaly dataset, incorporating the Tellus Border data and existing data from the Tellus survey in Northern Ireland (2005-6) and the pilot airborne survey in Cavan and Monaghan (2006).

Acknowledgements

This evaluation would not have been possible without the co-operation of a range of stakeholders (see Appendix A). We would like to thank all those who participated in this review and provided valuable insight.

SECTION 1

Executive Summary

1 EXECUTIVE SUMMARY

The Tellus Border project was a cross-border geo-environmental mapping project of Northern Ireland and the northern counties of the Republic of Ireland. The project was led by the Geological Survey of Northern Ireland in partnership with the Geological Survey of Ireland. Funding of £4,555,396 was provided by the INTERREG IVA programme. The project was a significant undertaking:

- First, it involved major data collection tasks covering more than 12,000km², with soil, water, sediment and vegetation samples from 3,500 sites and geophysical data from a low-flying plane which flew over 57,600km
- Second, the data collection affected a wide range of stakeholders, in particular landowners and farmers, and there was a potential for adverse publicity about the surveys
- Thirdly, the project collated, processed and analysed an immense volume of data. This included over 50 million geophysical measurements and over 750,000 geochemical analyses for soil, stream water and stream sediments
- Finally, the project engaged with a wide range of stakeholders, generated interest in the data and made the data available in a form that could be accessed.

In the context of these major challenges, the Tellus Border project:

- Was well scoped and planned, based on a well-thought through concept and an evidenced need
- Successfully delivered a complex and demanding data collection exercise in a controlled manner
- Operated robust quality control processes to ensure that the data met required minimum standards
- Engaged with stakeholders/the wider community through an exemplary communications campaign
- Managed the project (including risks and issues) in a proactive and effective manner
- Exceeded the funder's objectives as required in the Letters of Offer
- Has started to deliver wider economic and social benefits.

The project team, Steering Committee and the project contractors delivered a complex project with substantial risks and challenges in a highly competent and efficient manner. Significant value has been realised by stakeholders from the data generated by the project, though there continues to be a number of challenges to both quantifying this value and ensuring that full benefits are realised in the long-term.

The Tellus Border project has delivered as per the funder's letter of offer and on this basis there are no recommendations about the funded project. However a number of recommendations are made about taking the Tellus concept forward and continuing to deliver value from it. Because the Tellus Border project is complete, we envisage that these recommendations are considered by GSNI, GSI, DETINI and DCENR:

1. **Communications** – the project has created a wide range of technical papers and research. GSNI and GSI should work with relevant stakeholders (including Government Departments) to create further communication materials which are user-centric rather than technical centric. These will take the concept of the posters, but produce information that focuses very much on the user rather than the data/technical side. For example, "As a farmer, what can you tell me that would help my crops grow better?" Further, GSI and GSNI should continue the successful outreach programme, using the above materials to target non-technical users to help them understand how the data can help them address their very real problems

2. **RESI update** – the RESI document has provided the basis for the Tellus and Tellus Border projects. Fundamentally the strategy is sound. However the document is over 12 years old and does not reflect the insight/lessons learned from the successful delivery of the Tellus projects and other GSI or GSNI initiatives (including Infomar). We therefore recommend that GSI and GSNI see to update the strategy (working with other Government Agencies/Departments as appropriate), setting out a plan to extend geophysical and geochemical data collection in a prioritised manner to:
   - Include the rest of Ireland on a phased basis
   - Extend data collection offshore, particularly around Northern Ireland (as the Irish waters are being covered by the Infomar project)
   - Include additional data elements – for example a number of consultees expressed interest in water borehole data
   - Test the value of resurveying areas to provide time-series of particular data elements
   - Undertake further specific, targeted research based on feedback from the senior decision makers' outreach programme
3. **Research** – part of the value of the Tellus Border project has been the extensive research which crossed borders. This could be further extended with the inclusion of other Tellus projects, namely the Tellus South West and proposed GSI/BGS INTERREG V Ireland-Wales projects in a single coordinated approach to identifying, commissioning and driving out value from the data. Such an approach could facilitate greater use of a social media forum and the creation of applied research
4. **Data download** – In providing the current and future Tellus data, GSI should consider asking users for an e-mail address as part of the process for gaining access to data downloads (the web viewer would not require this). This could either be mandatory or optional, depending on GSI's/GSNI's appetite to identify users. Access to the data would still be free; however it would provide GSI/GSNI with a much better understanding as to who is downloading their data.

SECTION 2

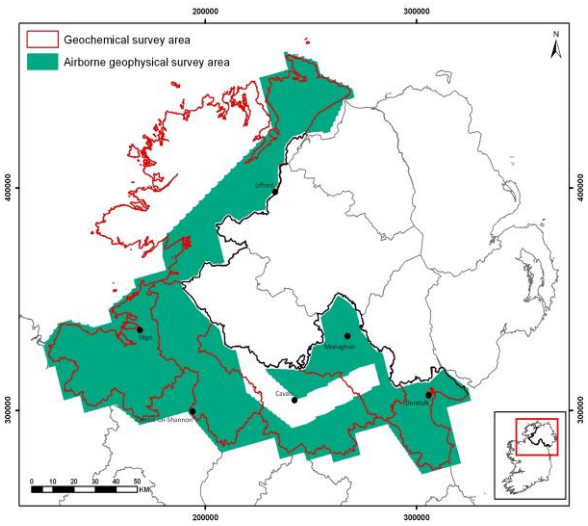
Introduction

2 INTRODUCTION

2.1 Background to the Tellus Border project

The Tellus Border project was a cross-border geo-environmental mapping project of Northern Ireland and the northern counties of the Republic of Ireland. The project was led by the Geological Survey of Northern Ireland (GSNI) in partnership with the Geological Survey of Ireland (GSI) and was financed by the INTERREG IVA programme of the European Regional Development Fund, managed by the Special EU Programmes Body (SEUPB). This project extended the mapping of Northern Ireland previously undertaken by GSNI under the Tellus Project but also included additional analysis of the original Tellus data. The total budget allocated by SEUPB was £4,555,396.

The Tellus Border project included a high-resolution, low-level airborne geophysical survey of counties Sligo, Leitrim, Cavan, Monaghan and Louth. In County Donegal the area southeast of a line between Donegal Bay and Lough Swilly has also been flown. The survey lines also extended for short distances into the counties to the south of the main survey area. The airborne geophysics survey is an industry-standard low-level survey, comprising measurements of magnetic field, radiometrics and electrical conductivity.



The Tellus Border project also included a baseline geochemical survey covering 12,339km², with soil, water, sediment and vegetation samples taken at 3,500 sites. The systematic sampling was undertaken at a density of typically 1 soil sample site per 4km² and one stream sample site per 3.5km². The newly acquired Tellus Border data was mapped and integrated with the existing Tellus data already available on the NI side of the border and interpreted on a regional scale.

The outputs of the Tellus Border project included:

- Multi-element soil and stream water and sediment geochemistry maps of the newly surveyed counties, amalgamated with those of contiguous border counties of Northern Ireland
- Magnetic field, electrical conductivity and radioactivity maps of the newly surveyed counties, amalgamated with those of contiguous border counties of Northern Ireland
- Integrated digital databases of the new Irish and existing Northern Irish data
- Environmental studies using these data that will inform management practices and disseminate the results at all levels. These studies or tasks include:
  - Soil and stream chemical characterisation of cross-border catchments
  - Delivery of data required by the (expected) Soil Framework Directive, the Water Framework Directive and the Nitrates Directive, Framework Convention on Climate Change
  - Hydrological, hydrogeological and hydroecological characterisation of wetlands
  - Mapping of groundwater pollution plumes from isolated waste sites
  - Estimation of peat depths, based on attenuation of airborne radioactivity and GIS/geostatistics
  - Detailed areal mapping of levels of natural and artificial radioactivity.

The data was made available to anyone free of charge in 2013 via the Tellus Border website. Following completion of the Tellus Border project, DCENR, DETI, GSI and GSNI commissioned PA Consulting Group (PA) to undertake a Post Project Evaluation in line with Department of Finance and Personnel guidance (http://www.dfpni.gov.uk/eag), with a level of detail commensurate with the level of expenditure.

2.2 Terms of reference and evaluation objectives

The specific terms of reference for the post project evaluation were as follows:

- Explain the strategic context of the project
- Outline the rationale, aims and objectives of the project
- Assess achievement of objectives in relation to timeliness and expenditure as per Letter of Offer
- Interview key stakeholders
- Assess risk management
- Define assumptions, identify side effects and distribution effects
- Overall assessment for value for money
- Make recommendations to assist in planning for future phases of Tellus (in particular how Tellus coverage might be extended to the rest of Ireland) and how the data might be further exploited
- Provide a full and detailed report on each of the steps
- Present/disseminate results to GSI and GSNI.

2.3 Methodology

The post project evaluation included the following steps:

- Consultation with a range of stakeholders and interested parties as set out in Appendix A
- A review of project documentation, as set out in Appendix B
- Analysis of licence data and financial returns.

2.4 Structure of this document

This report is set out in three further chapters as follows:

- Chapter 2 sets out the strategic context for geochemical and geophysical data in Northern Ireland
- Chapter 3 presents the review findings
- On the basis of these, Chapter 4 lists the conclusions and recommendations of the evaluation.

This report also has four appendices as follows:

- Appendix A lists the stakeholders who were consulted as part of this post project evaluation
- Appendix B lists the documents reviewed
- Appendix C lists the research papers produced by the Tellus and Tellus Border projects
- Appendix D sets out the acronyms used in the report.

SECTION 3

Strategic context

3 STRATEGIC CONTEXT

3.1 Role of GSNI and GSI

3.1.1 Geological Survey of Northern Ireland

GSNI is an office of the Department of Enterprise, Trade and Investment (DETI) of Northern Ireland which provides advice on all geological matters to Northern Ireland government departments and industry, academia and the public.

GSNI, which has been operating since 1947, is a relatively small body with approximately 15 staff, the majority of whom are technical (geoscientists and scientific support) staff. Some of the technical staff are drawn from the British Geological Survey (BGS) under an agency agreement which allows the GSNI to utilise expertise in other parts of BGS. The BGS is part of the Natural Environment Research Council (NERC), the UK's main agency for funding and managing research, training, and knowledge exchange in the environmental sciences.

3.1.2 Geological Survey of Ireland

GSI is the national earth science agency in Ireland and is responsible for providing geological advice and information, and for the acquisition of data for this purpose. GSI produces a range of products including maps, reports and databases and acts as a knowledge centre and project partner in all aspects of Irish geology. GSI is a Line Division of the Department of Communications, Energy and Natural Resources (DCENR) and has approximately 40 multi-disciplinary staff.

GSNI and GSI operate independently of each other, though freely share data, collaborate on the production of maps (e.g. the Geological map of Ireland, 2007), participated in joint projects (funded by INTERREG and other North-South bodies) and undertake joint stakeholder events (e.g., 'Geoscience: the Foundation of our Future', 2008). The approach to joint working is formalised through a Framework Agreement for Increased Scientific Cooperation signed by GSI, GSNI and BGS on the 1st November 2007. The agreement formalises and recognises the cooperation that has existed between the Geological Surveys but it also provides the structure and support to grow and shape a beneficial and productive long-term relationship between the organisations.[1]

3.1.3 A geophysical and geochemical survey of the island of Ireland

The idea of a comprehensive geophysical and geochemical survey of the island of Ireland was conceived as the Resource and Environmental Survey of Ireland (RESI) in the late 1990s in discussions between DETI, GSNI, GSI and the BGS with the idea of providing modern geoscience information to inform government decisions and promote investment in natural resources exploration and development.

The concept was further developed when two scoping studies were produced by the geological consultancy CSA Group Ltd, one for Ireland (2002) and one for Northern Ireland (in 2003).[2] At the same time the Environmental Institute of University College Dublin undertook a cost-benefit analysis of

[1] http://www.gsi.ie/Newsletters/GM08_International+Cooperation+and+Agreements.htm

[2] The Resource & Environmental Survey of Ireland, Northern Ireland, CSA, (2002 and 2003)

the Irish element of RESI. The analysis revealed that the benefits of the RESI would far outweigh the costs of undertaking the survey, with a projected mid-range cost:benefit ratio of 1:5.[3]

Finding: 1. The concept of a cross-border geophysical and geochemical survey was one that GSI and GSNI had jointly developed over a number of years. The concept had been worked up using evidence collated from a number of independent technical and economic analyses undertaken by credible parties.

3.2 Project Tellus

While the intention was to collect and collate geophysical and geochemical data on an all-Ireland basis, the lack of funding in Ireland available at that time meant that the Northern Ireland component went ahead separately and branded as the Tellus project in October 2004.

Prior to the Tellus Project, the last regional geophysical survey of Northern Ireland had been carried out by the BGS in 1959. This was an airborne survey, measuring only the magnetic field and the broad structural elements at a regional scale. Since then, geophysical survey equipment has become significantly more accurate and sophisticated. The previous geochemical survey had been carried out by the Department of Agriculture and covered only sixteen elements. While these datasets provided some baseline data, it was recognised that there was a need for a high resolution geophysical and geochemical survey of Northern Ireland.[4]

As a result the Tellus project was developed. It was funded by DETI through the Building Sustainable Prosperity fund managed through the Rural Development Programme and led by GSNI. The £5.82m geophysical and geochemical surveys took place between April 2004 and March 2007.

The Tellus project was delivered on time (the outputs as specified in the economic appraisal), within budget and to the required quality standards. While there were a number of delivery issues, for a project of this size and complexity these were minor. Overall, the project controls worked well and supported the overall delivery of the project. The Tellus project in Northern Ireland provided a successful blueprint for future similar projects.

In terms of outcomes of the project, an independent evaluation[5] undertaken shortly after project completion highlighted that the project had a positive impact in line with or above those projected in the economic appraisal (where full benefits realisation was expected to take decades). Benefits included licensing of the data by commercial organisations, use of the data by academic researchers and use of the data by the public sector. However in most cases data exploitation was at a relatively early and immature stage. This accepted, all stakeholders recognised the quality of and potential value of the Tellus data. The evaluation also confirmed that the CSA cost:benefit projections were credible. Further high-level analysis of the Tellus impact has suggested an even greater return on investment - of the order of £8 return for every £1 of survey costs.[6]

In addition to the expected outputs, the Tellus project:

- Showed that GSNI had a proven capability to manage the delivery of complex geophysical and geochemical surveys at a regional level
- Highlighted a demand by stakeholders for the data and for similar surveys elsewhere
- Demonstrated that more could be done with the data that had been collected.

Recognising the success of the project, BGS have used the Tellus project as the basis for a similar project in the south west of England (“the Tellus South West Project”).

[3] Cost benefit analysis of a resource & environmental survey of Ireland, Environmental Institute University College Dublin (2001)

[4] RESNI Economic Appraisal (PwC, March 2004), section 3.8

[5] Post-Project evaluation of the Tellus Project, PA Consulting Group (August 2008)

[6] The Tellus Experience: A Mineral Exploration Perspective, Garth Earls, April 2012 at Geoscience 2012 conference in Dublin Castle

Finding: 2. The successful delivery of the Tellus project (on time, to budget and with the benefits in excess of those projected at that stage) demonstrated that the concept of a widespread geophysical and geochemical survey was realistic, there was a demand for the data and that the underlying technical and economic analyses were appropriate. The application of Tellus to the south west of England by BGS provides further validation of the approach.

3.3 Tellus Border project development

Following discussions between GSNI, GSI and four other potential partners (Queens University Belfast [QUB], Dundalk Institute of Technology [DkIT], Environmental Protection Agency [EPA] and the Northern Ireland Environment Agency [NIEA]), GSNI submitted an application to the SEUPB to undertake a new project ("the Tellus Border project") to be funded under the INTERREG IVA Northern Ireland, the Border Region of Ireland and Western Scotland, Priority 2, sub theme: Environment. The proposal was that the four partner organisations would establish a new project to:

- Undertake similar data collection to the Tellus project for the contiguous border counties of Ireland
- Publicise and make freely available this data to Government, private companies and the general public
- Undertake a variety of research projects that demonstrate the value of the Tellus and Tellus Border data.

Finding: 3. The Tellus Border project was not simply the Tellus project being replicated in another region. Rather it sought to extend the use of existing Tellus data through a number of post-doctoral research projects. Thus while data collection only took place in Ireland, there was a significant cross-border element that built upon one of the key findings of the Tellus project (i.e. that more could be done to exploit the Tellus data that had been collected). Further the Tellus Border project sought to make the data available free of charge – a further difference from the Tellus project.

Funding of £5,189,419 was sought. The aim of the project, as stated in the application, was:

"to maintain or improve the condition and management of soils, stream waters and groundwaters in the North of Ireland. This will be achieved by collecting coherent and consistent geoscience data, analysing the results, identifying existing problems and threats, and disseminating information.

Geo-environmental data (i.e., data of the physical and chemical properties of soil, waters and rocks) are essential to informed sustainable environmental management and land-use planning. Modern data have been collected in Northern Ireland but not in the RoI border counties. The project will undertake state-of-the-art geoscience (i.e., geochemical and geophysical) surveys of the border counties of RoI, amalgamate the results with existing data from NI, and use these data to inform and improve management practices for land resources, soils, waters and wetlands.

The project will be accompanied by a managed and targeted programme of scientific outreach at three levels: national government, local government and communities. This outreach programme will raise awareness of the importance of sustainable use and management of geo-resources."[7]

The application also set out a number of targets, which as per Government guidance were specific, measurable and time-bound statements of what the project wanted to achieve:

5. *"Publish multi-element soil and stream geochemistry maps of the newly surveyed counties, amalgamated with those of contiguous border counties of Northern Ireland (completion by month 30)*

[7] Tellus Border project Application Form (Part B), GSNI (July 2009) Section 2.3

6. *Publish magnetic field, electrical conductivity and radioactivity maps of the newly surveyed counties, amalgamated with those of contiguous border counties of Northern Ireland (by month 30)*
7. *Establish integrated digital databases of the new RoI and existing NI data (by month 36)*
8. *Undertake environmental studies using these data that will inform management practices and disseminate the results at all levels (by month 36). These studies or tasks will include:*
    a. *Soil and stream chemical characterisation of cross-border catchments*
    b. *Delivery of data required by the (expected) Soil Framework Directive, the Water Framework Directive and the Nitrates Directive, Framework Convention on Climate Change*
    c. *Hydrological, hydrogeological and hydrochemical characterisation of representative wetlands*
    d. *Mapping of groundwater pollution plumes from isolated waste sites*
    e. *Estimation of peat depths, based on attenuation of airborne radioactivity and GIS/geostatistics (which contributes to carbon inventory calculations)*
    f. *Detailed areal mapping of levels of natural and artificial radioactivity.*

Deliverables for these research projects will include, for each study, at least two peer-reviewed scientific publications and the mounting of a mobile public exhibit and information display."[8]

Finding: 4. The targets for the Tellus Border project were consistent with the project aims and, given the benchmark established by the Tellus project, were credible in terms of scope, timescale and cost.

The funding application was supported by:

- A detailed project delivery plan
- Financial projection
- Clear governance and reporting structures
- Detailed job descriptions with proposed candidates for key positions (who met the requirements)
- A detailed communications and stakeholder engagement plan (which addressed a key risk, namely claims resulting from damage to livestock caused by the low-flying data collection)
- Letters of support from all partners and other key stakeholders.

These documents drew upon the experiences and insight gained from the delivery of the Tellus project, for example typical market costs of data collection, timescales for delivery, risks and issues.

Finding: 5. The application for the Tellus Border project was built upon the Tellus project - a project that had been effectively delivered and had started to produce the long-term projected benefits. The Tellus Border funding application was well written, comprehensive, evidence-based and extremely credible.

SEUPB commissioned an independent economic appraisal of the funding application. As part of the appraisal a number of alternative options (including changes to the scope of data collection) were considered, however the appraisal did not recommend significant changes to application. Importantly the appraisal highlighted:

"discussions with the promoters would indicate that no further monies are available from Government sources. Private sector funding has been expended in undertaking limited mapping in the border counties (in pursuit of opportunities for mineral exploration). There is considered to be significant risk attached to the proposed project as a commercial venture to identify minerals. No private sector funding is considered to be available at this stage in the mapping process. The costs of exploration

[8] Tellus Border project Application Form (Part B), GSNI (July 2009) Section 2.3

are likely to be high, however, should precious minerals be found, ie after this project, this would be the point at which the private sector may engage."[9]

The appraisal concluded that the Tellus Border project would not proceed without INTERREG IVA funding. While some privately funded geophysical and geochemical surveys do take place[10], they cover relatively small areas and the data are not always made more widely available for general use.

Finding: 6. The economic appraisal and previous lack of private sector funding confirmed the fact that the Tellus Border project (and indeed a widespread geophysical and geochemical survey on the island of Ireland) was truly additional – it would not happen without public sector intervention.

Following a review by the INTERREG IVA, Priority 2 Steering Committee on 1st July 2010, the project was notified that they were to receive funding of up to £4,014,609.[11]

Ministers Arlene Foster (DETI) and Edwin Poots (DOE) announce the funding of the Tellus Border project. Pictured with them are the then Vice-Chancellor of Queens University (Peter Gregson), Mike Young and other members of the team.

Minister Rabbitte at the Project Launch event, 4th July 2011, Cavan.

[9] Geo-environmental survey of the north of Ireland 'GESI North' - economic appraisal, BDO (June 2010), p56

[10] For example Aurum Exploration Ltd undertook a small aerial survey in northeast Mayo in 2012

[11] Letter of offer, SEUPB, 30th September 2010

SECTION 4

Evaluation findings

4 EVALUATION FINDINGS

4.1 Inputs – governance, finances and resources

4.1.1 Governance and project management

The Tellus Border Steering Committee was established when the project commenced and included representation from the following organisations:

- GSN
- BGS
- DETI
- DECLG
- DkIT
- GSI
- NIEA
- DCENR
- QUB
- EPA.

The Tellus Border project managers attended the Steering Committee. The role of the Steering Committee was discussed and agreed at the first Steering Committee meeting as follows:

- *"Provide political and strategic guidance to the Project Manager and Project*
- *Provide high-level coordination between the partners and between RoI and NI*
- *Advise on relationships with stakeholders*
- *Receive and comment upon the quarterly and annual reports*
- *Decide on appropriate external evaluation processes."*[12]

A Partner's Committee (PC) was established, reporting to the Steering Committee. In addition five Technical Advisory Groups (TAGs) were established to provide advice to the geophysical and geochemical surveys and the three postdoctoral research projects, to "*advise on the design and progress of the several tasks and to minimise duplication with previous or other work elsewhere*".[13]

The Steering Committee met quarterly with meeting dates agreed well in advance. The meetings were structured in an appropriate manner. From the meeting minutes it is clear to see that the majority of committee members attended the meetings (either in person, by video conference or by proxy), the meetings were chaired, minutes and action points recorded, and papers circulated in advance of each meeting. The quality of the minutes and supporting papers was high – documents were well-structured, concise and identified key issues/decision points. Financial reports and projections carried appropriate levels of information to support oversight and control.

The Steering Committee considered progress of the delivery of the project around six core themes:

- Project management
- Financial status
- Communications
- Geophysical survey
- Geochemical survey and
- Post-doctoral research.

The Committee meetings were minuted, including thorough progress papers and actions. Any action points were noted and signed-off during the course of the subsequent meetings. The meetings helped drive the objectives but also tied in with the SEUPB reporting cycle, providing a review of expenditure at each meeting prior to submission to the funder.

> "*The project was successful by bridging not just geographical borders but also bringing the scientific disciplines and communities to work together.*"
> Andy Howard, BGS

[12] Steering Committee meeting 25 January 2011, Annex A

[13] Steering Committee meeting 25 January 2011, minute item 3

Finding: 7. The project's overall governance structure was relatively simple but appropriate for a project of this magnitude and complexity. It had senior representation from key stakeholders. Further, Steering Committee members were able to provide appropriate guidance to the project team around specific issues. The Steering Committee worked well, had appropriate membership, provided appropriate oversight of project progress and signed-off of key deliverables delivery.

As part of the first Steering Committee meeting (25th January 2011), a paper was circulated that set out the project background, goals, objectives and partner responsibilities.[14] This paper set out similar (but not identical) objectives and project goals to the original application. The differences were not substantial; rather they reflected a more operational perspective on what the project could actually achieve. For example the original stated aim of the project in the application form ("*to maintain or improve the condition and management of soils, stream waters and groundwaters in the North of Ireland")*[15] was unlikely to be achieved by the project alone. The Steering Committee paper set out more realistic and appropriate goals (e.g. "*to provide high quality fundamental geo-science datasets and information to ensure sustainable use of natural resources in the project area and to inform sustainable management of environmental resources."*)

Finding: 8. The objectives for the project agreed at the first Steering Committee meeting differed slightly from the original application, though the changes were immaterial.

The delivery of Tellus Border project was structured around the following key tasks (each of which had their own nominated task lead):

- Task 1: Project Management, essentially overseeing the project and ensuring that it is managed in an appropriate and effective manner
- Task 2: Outreach, specifically public liaison in advance and during field surveys, outreach to universities, presentations at scientific and industrial conferences, to government and to local interest groups and development of web pages
- Task 3: Airborne surveys, primarily the collection of airborne geophysical data and processing of this (with magnetics, electromagnetics, and radiometrics)
- Task 4: Geochemical surveys, including the collection of geochemical samples and processing of data from soils, water, and stream sediments
- Task 5: Post-doctoral research.

Progress against the agreed project plan was monitored by the project team and reported to the Steering Committee on a quarterly basis. The status of each task and sub-task was clearly identified, with exceptions highlighted. Project risks and issues were also reported on.

Finding: 9. Delivery of Tellus Border project was divided into a set of sensible and logically delineated tasks, each with clearly defined outputs and progress being measured for each task at quarterly Steering Committee meetings.

The original funding application identified the team required to deliver the project, including roles, responsibilities and the skills, experience and capabilities for each team member. Suitably experienced individuals were recruited to the team (both north and south of the border). This included team members who helped deliver the Tellus project and therefore brought significant experience and insight. Overall, the core project team had a strong combination of technical, procurement and project management and delivery experience.

– The project did have some challenges around recruitment for the post-doctoral research positions – this reflected the relatively limited pool of qualified individuals (particularly PhD level)

[14] Steering Committee meeting 25 January 2011, Annex B

[15] Tellus Border project Application Form (Part B), GSNI (July 2009) Section 2.3

and the demand on such skills from industry which commands higher salaries (though the roles were advertised internationally). However this issue was managed and had no lasting impact on project delivery.

Finding: 10. The project delivery team was appropriately specified, efficiently established and sufficiently robust to evolve in response personnel changes. The project team brought an impressive and comprehensive combination of skills across geophysical and geochemical surveys, project management, procurement and communications.

Because the project team was not based from a single site, there were potential challenges around inter-team communications. However discussions with the team and wider stakeholder group highlighted that this did not materialise and that the levels of communication across the team were excellent. Given the duration of the project, not surprisingly there were changes in the core project team. These changes were not caused by the project itself, but reflected wider factors, e.g. individuals being promoted. Any staff changes were effectively managed and had no impact on project delivery/continuity.

Finding: 11. There were no staff retention issues during the delivery of the project – this indicates a very positive operating environment where team members felt valued and enjoyed their work.

Day-to day project delivery was in line with accepted project management standards, with a clearly articulated plan to the appropriate level of detail, well defined deliverables that cascaded down from the project objectives and appropriate risk management. There was regular project reporting, with weekly team meetings. These had clear agendas, documented actions and considered risks on on-going basis. This was supported by high quality records – documents were well-structured and presented, with clear accountability for and tracking of actions.

> *"Management of the project was fabulous and streamlined compared to other research projects I have participated in."*
>
> Valerie McCarthy, DkIT

The project had a high degree of transparency, with papers (in particular Steering Committee papers) shared with team members and appropriate stakeholders both formally and informally. This was supported by a high level of informal project team engagement/discussion. The project team also participated widely in the communications delivery, including a successful rota that provided out-of-office hours response to enquiries during the airborne surveys.

Finding: 12. Project management and communication was extremely strong and effective, with team members actively participating in wider communications.

Discussion with the SEUPB noted that the Tellus Border project was a "*benchmark for project management*", with a "*significant amount of value added activity accommodated within the overall budget*"[16] in addition to meeting the required aims and objectives.

Finding: 13. Overall, the Tellus Border project was managed in a highly efficient and effective manner.

The table over sets out the reporting timescale/frequency.

[16] Discussion with Ciaran Hanna, SEUPB, 10th April 2014

Reporting	Frequency
Steering Committee meetings	14 meetings to date, held quarterly
Project team meetings	Weekly
Reports to SEUPB	13 reports, issued quarterly
Annual Reports	4 produced, each at end of calendar year
Post Project Evaluation	Commenced February 2014

4.1.2 Finances

SEUPB were the main funders. As a result, the project sensibly aligned financial reporting with SEUPB's requirements. GSNI were the lead partner with SEUPB, and assumed responsibility for overall administrative and financial responsibility for the implementation of the project under SEUPB's Lead Partner Rules.

Funding for the project was formally approved on 30th September 2010. This funding was subsequently increased to £4,555,396 by an Addendum to the Letter of Offer on 26th November 2013 for further geochemical analysis and research. The final approved costs were therefore as follows:

	ERDF	Match	Total
Ireland	£922,322	£307,441	£1,229,763
Northern Ireland	£2,494,225	£831,408	£3,325,633
Total	**£3,416,547**	**£1,138,849**	**£4,555,396**

Project expenditure was broken down as follows:

Item	Total Project Cost (£)
Capital	10,800
Salaries and Wages	1,030,839
Goods and Services	178,291
Programme Costs	3,335,466
Total Project Costs	**4,555,396**

At the date of writing the evaluation £4,161,729.26 had been successfully claimed from the respective partners, with £393,666.74 being claimed in the final claim later in 2014. There have been a number of very small issues raised in relation to claims; however SEUPB considered these to be minor and the respective partners picked up the rejected expenditure in full.

The Letter of Offer required the Lead Partner to submit a Quarterly Progress Report to SEUPB comprising an update under the following categories:

- Work plan activities and progress against plan, including scope and impact of additional activities undertaken
- Details of how the aims/objectives of the Letter of Offer were met by the activities in that quarter
- Risks and issues
- Expenditure update
- Checks and sign-offs.

The Steering Committee minutes and discussions with SEUPB showed that the Lead Partner fulfilled all obligations with regard to quarterly reporting in a clear, timely and comprehensive manner.

Finding: 14. The project finances were managed in an efficient and effective manner, with appropriate governance and oversight from the Steering Committee. Financial reporting met all funder requirements.

Whilst the rules and regulations for the INTERREG grant were found to be more onerous for partners than their own procurement guidelines (e.g. a detailed procurement file required for every purchase over €200/£200), they were ultimately able to account for and address these requirements successfully. In addition SEUPB released less onerous procurement guidelines during the course of the project

The project team demonstrated adaptability over the course of the project lifetime. For example, when it was discovered that the claimable overheads costs in the budget had been overstated by approximately £124k, the project team successfully negotiated with SEUPB to have the costs reapplied to programme costs and spent on research calls. This eliminated the risk of losing the funds in their entirety and enabled achievement of greater value for money against the core objectives.

Finding: 15. Strong project and financial management allowed the project to rapidly exploit opportunities, for example when SEUPB identified unspent funds in their INTERREG IVA budget.

4.1.3 Resources

The specialist nature of some of the Tellus Border project tasks meant that external assistance was required - this was something that was always envisaged and reflected the experience of the Tellus project. The project therefore brought in specialist expertise/services from third party providers through a number of open competitions. Procurements followed the SEUPB guidance notes on procurement. Project team members had run public sector procurements before, including similar procurements on the Tellus project. Indeed through Tellus, the project team had a good understanding of supply base and likely costs.

Specifying the services/outputs is often the most difficult and risky part of any procurement. Technical standards for the geophysical and geochemical surveys had been prepared in advance of the tendering process and the project team were able to rely on individual expertise gained from the original Tellus project. This was therefore not an issue.

By the end of the project, 4 primary external contractors were used, namely:

- Sander Geophysics Ltd (SGL) – responsible for the airborne geophysical survey
- OCAE Consultants Ltd – responsible for sample collection in the geochemical survey
- Morrow Communications – responsible for the delivery of the project outreach and communications
- British Geological Survey – responsible for geochemical analysis and also geophysical data processing and data quality review.

These external resources delivered to agreed technical standards. These resources also brought experience of dealing with the relevant stakeholders, for example OCAE Consultants had worked within the Irish farming community previously. A number of stakeholders reported that the use of trusted agricultural consultants for the soil sampling had a two-fold positive effect. Firstly, it increased trust within the farming community enabling the work to progress without significant delay or interference, and secondly, it generated a deeper level of anticipation and expectation on the actual soil results when they were available.

Finding: 16. In spite of potential for issues relating to complex and technical specifications, the use of external contractors was a success on this project. These contractors were able to provide added value, in particular in their relationship with certain stakeholders.

The Project Team also utilised a number of external parties to aid the effective delivery of the communications programme, for example the Irish Farmers Association, which was an invaluable source of support in ensuring effective engagement with the local farming community.

4.2 Project delivery and outputs

4.2.1 Data collection

Airborne geophysical survey

The airborne geophysical survey took place between 26th October 2011 and 15th July 2012. The contractor, SGL, was successful in the tendering process from a pool of 5 bidders. The geophysics specifications for Tellus Border were exactly the same as for the Tellus project in Northern Ireland, and included a 500m overlap with the Tellus dataset.

SGL was awarded the contract in May 2011 but delays in both the mobilisation of the aircraft and the attaining of a licence from the Irish Aviation Authority meant that the survey commenced 5 months behind schedule. As a result of this more of the geophysical survey was flown in autumn/winter, with:

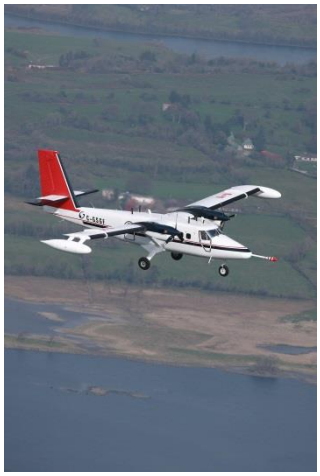
- A greater incidence of cancelled flights (data collection) due to bad weather conditions than planned for (based on the Tellus project)
- Shorter daylight hours within which to complete the flights.

This meant that the data collection itself took longer than expected. Conversely it has been argued that autumn/winter data collection has some advantages, in particular with fewer members of the general public outside during the data collection leading to a decreased likelihood of complaints.

Some areas had flights cancelled on more than one occasion which did result in some inconvenience and frustration to livestock owners in that area (multiple communications about low-flying which did then not actually take place when expected due to weather conditions). In addition, some high-fly zones had to be employed to accommodate wind farms and other natural terrains than precluded flying at the specified height – this would have happened regardless of when the data were collected.

Finding: 17. The nature of airborne data collection involved a degree of risk, including from factors outside the contractor's control. In practice this meant that the data collection was delayed slightly and took longer than scheduled. While this was an issue at the time, in the wider context this higher risk data collection element was completed without significant incident.

The airborne survey operated 7 days a week over 38 weeks and covered 10,484km². There were a total of 177 flights, with 12 cancelled and 39 returning early due to bad weather conditions.



It was suggested by a few consultees that there was a slight degradation in quality of the geophysical data relative to the Tellus dataset, though the data quality was within the required standards. Evidence showed that the geophysical data collected was assessed against technical standards on a weekly basis and a report issued to the contractor indicating whether data was acceptable or not, with exceptions noted within each report. It is clear from the evidence reviewed that the process of accepting data from the contractor to the project team was carried out diligently, comprehensively and consistently throughout the collection stage and ensured that the data met the required standard.

Finding: 18. There was a weekly feedback to the contractor on the geophysical data received, providing robust and timely assurance as to data quality. These seemed to operate effectively with data collected to the required standard.

SEUPB indicated that because the aerial survey started 5 months behind schedule, there was a risk that funding for the survey may have been lost. However this did not transpire and project funding was ultimately not affected. It has been suggested that the contract with SGL could have been 'stronger' if it had included provision of financial penalties for failure to meet the agreed timescales. While this can work, allocating responsibility for the cause of delay can be extremely problematic (and therefore

expensive and time-consuming) and ultimately any supplier will increase their price to reflect the additional risk to the supplier. Alternatively they might ask for a reward for providing the data early.

A key project risk related to the airborne survey, specifically the risk that low-flying aircraft would frighten livestock. The project team were well aware of this risk, had experience of managing it on the Tellus project and sought to address it through a robust communication strategy.

A series of press releases, public information notices, presentations, flier and letter mail-outs, local radio interviews, regular newsletters and traffic alerts ensured that awareness of survey activities remained high throughout the survey period. A dedicated freephone information line, email address and website together with daily phone calls to interested animal owners allowed effective two-way communication with members of the public. The freefone line received 143 calls during the duration of the airborne survey, whilst the email address received 172 email enquiries.

One of the publicity leaflets used to support the Tellus Border data collection.

Local landowners and farmers were targeted via a combination of widespread advertising across a number of media channels, coupled with specific communications in advance of specific flights. Given that Ireland did not have a postcode system in operation at the time of the airborne survey, the process used on the Tellus project had to be adapted to ensure successful delivery – basically proportionally more letters went out on the Tellus Border project than the Tellus project. The targeting of users in those areas being flown allowed livestock owners to take appropriate action in advance of

the flights, for example moving their stock indoors. Targeted measures including phone calls (111 in total) were undertaken to make sure that horse owners were aware of the survey and that their concerns were fully addressed. Furthermore, the project team sought to address/accommodate specific seasonal circumstances, such as the effects on sheep during the lambing season.

Flight plans, consisting of a map showing the planned flight lines for the next week, were sent to 56 interested parties and posted on the website on a weekly basis. As some of the flying zones were adjacent and parallel to the M1, the project team and communications partner alerted the public via radio traffic bulletins and M1 variable message signs over a 10 day period - it was estimated that these reached up to 500,000 listeners each day and 300,000 road users.[17] This action was again commended by a number of stakeholders for both explaining to the public to the immediate impact of the survey and also providing a wider audience with an awareness of the data that would be made available as a result of the flights.

In practice, a small number of claims arose as a result of the aerial survey, which were paid by the contractor. The incidence of claims was at a comparable level to the original Tellus project. Those stakeholders consulted highlighted that effectiveness of the communications strategy and its delivery in mitigating a significant risk.

Finding: 19. The communications strategy and its delivery effectively helped mitigate the risk of major claims for damage to livestock and avoid any negative publicity.

During the project period, a private company (Aurum Exploration Services, on behalf of Oriel Selection Trust) undertook a similar aerial survey of a small adjacent area in County Mayo using the same plane and contractor used for the Tellus Border survey. Following discussions with them, this data was made available to Tellus Border in December 2012 and made publicly available in 2013, thus extending the overall coverage of the geophysical survey against the original specifications. The company was able to benefit from the mobilisation of the aircraft and were able to adapt the Tellus Border communications plan. The value of this additional data to the project was approximately €100k.

Finding: 20. The project benefitted from a private company undertaking a small survey in an adjacent area, extending the overall coverage of the geophysical survey against the original specification at no cost to the project. This would not have happened without significant goodwill between the private company and the project.

On completion of the geophysical survey, a technical report[18] was completed providing detailed background as to the data collection process, equipment and standards.

The provision of the data by the contractor was also delayed. The last survey was on 22nd July 2012 with delivery of the final magnetic and radiometric data expected on 24th September and the 22nd October 2012 for the electromagnetic data. The delay in receipt resulted in time pressures on Tellus Border team members to verify and produce final merged data sets in time for the planned launch of the data on 5th February 2013.

After the data was received, it was processed in conjunction with BGS and merged with the Tellus dataset. This process was documented in the Airborne Geophysics Data Processing Report, issued in January 2013 and is now published on the Tellus Border website. Subsequently, interpretation and data merging projects have been completed, for example, data from the Radiological Protection Institute of Ireland (RPII) was georeferenced to help test prior Radon models. The geophysical and electromagnetic data has also now been made freely available via the viewer on the Tellus Border website. In addition, the Tellus geophysicist accompanied RPII on a coastal monitoring round and assisted in Caesium 137 analysis.

[17] Tellus Border Communications Programme Report, GSI/GSNI, 2014

[18] Airborne geophysical survey logistics report, GSNI/GSI, March 2013

Interviewees with a wide range of stakeholders revealed that the data collected was to the standards specified, although a number indicated that the lack of complete coverage of the Donegal area was disappointing, with northwest Donegal not being flown within the survey. A few consultees indicated that the commercial sector had reported some disappointment with the geophysical results (specifically the electromagnetic data as specified), but the majority indicated that the data provided is of a sufficiently high standard.

Finding: 21. The geophysical data collection was a success – more data was collected than planned for/funded (with the inclusion of a private sector data set), the data was collected to the required standard and there were no major issues with landowners, farmers or the general public.

The table below sets out the geophysical survey timeline.

Event	Date
Issue of tender	April 2011
Tender awarded	May 2011
Start of aerial survey	October 2011
End of aerial survey	July 2012
First data received from contractor	October 2011
Final data received from contractor	October 2012
Analysis and interpretation of data started	July 2012
Publication of results	February 2013 – May 2013
Publication of reports	February & October 2013

Geochemical survey

The geochemical data collected comprised the following:

- Stream sediment samples
- Stream water samples
- Topsoil samples.

Data was collected to the following technical specifications:

	Analytical method	Chemical determinants
Stream sediment	X-ray fluorescence spectrometry (XRFS)	K, Ca, Ti, Mn, Fe, S, Cl, Sc, V, Cr, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Rb, Sr, Zr, Nb, Mo, Nd, Sm, Yb, Hf, Ta, W, Tl, Pb, Bi, Th, U, Ag, Cd, Sn, Sb, Te, I, Cs, Ba, La, Ce, Na, Mg, Al, Si, P, Ba, Y, In.
Stream water	Stream water pH, electrical conductivity, alkalinity (bicarbonate); organic carbon (NPOC) analyser; ion chromatography; ICP-MS	NPOC, Cl-, SO42-, NO3-, Br-, NO2-, HPO42-, F-, Li, Be, B, Na, Mg, Al, Si, P, S, K, Ca, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Rb, Sr, Y, Zr, Nb, Ag, Cd, Sn, Sb, Cs, Ba, La, Ce, Pr, Nd, Sm, Eu, Tb, Tm, Yb, Lu, Hf, Ta, W, Tl, Pb, Bi, Th, U, Ti, Mo, Gd, Dy, Ho.
Topsoil	ICP(-OES/-MS) following aqua regia digestion; soil pH, soil loss-on-ignition at 450°C	Al, B, Ba, Ca, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, P, S, Sr, Ti, V, Zn, Zr, Ag, As, Be, Bi, Cd, Ce, Co, Cs, Ga, Ge, Hf, Hg, In, La, Lu, Mo, Nb, Pb, Rb, Sb, Sc, Se, Sn, Ta, Tb, Te, Th, Tl, U, W, Y, Yb

Sampling fieldwork commenced in July instead of May 2011 as planned, however, sampling was finished ahead of schedule in May 2012 (anticipated July 2012).Approximately 7,000 sites were visited over the course of the survey; approximately 1 sample per 3.5 km² and a total of 12,312 km² covered. The survey design was based on sampling of one location from each cell in a fixed grid of 2 km by 2 km gridlines in order to ensure even coverage of samples. The sampling methods involved the collection of small volumes of samples by hand auger with all sites visited left undisturbed.

The sampling methodologies are based on those developed by the British Geological Survey G-BASE programme, i.e. a recognised and accepted industry standard and as used in the Tellus survey, allowing comparison and merging of the data.

Minister Fergus O'Dowd TD takes the last sediment sample of the geochemical survey near Ardee, Co. Louth in June 2012, assisted by pupils from St. Mary's Boys National School, Drogheda.

The geochemical survey posed fewer public relations challenges than the low-flying aircraft employed in the geophysical survey. However, the communications strategy was still successfully relevant to this aspect. In particular many stakeholders highlighted the use of experienced agricultural consultants, OCAE Consultants, who gained a high level of trust within the communities required to grant access to the surveyors.

The data quality reported by stakeholders was high, although some indicated a variance in the Tellus and Tellus Border dataset due to the different seasons in which the data was collected.

The geochemical field data was quality assured by the Project Team and reported back to the contractors via regular weekly reports during the survey, creating a full auditable trail of data signoff and requests for re-surveys. The field data was eventually processed and handed over by the contractor in December 2012.

The topsoil and stream sediment sample preparation was completed on 17 October 2012. Sediment samples were passed to a BGS subcontractor, PANalytical. Prepared soil samples were shipped from the BGS preparation facility in Keyworth to the SGS analytical lab in Toronto in 8 consignments. Final delivery was on 19th October 2012. This contract completed well on time and on budget. Stream sediments XRFS analysis was also processed by BGS, subcontracted to PANalytical; this analysis was completed and final data delivered on 20 November 2012 with the contract also completed within time and on budget. The aqueous analysis was completed by BGS Aqueous Inorganic Geochemistry Laboratories. The stream waters analyses were completed and final data delivered on 14th December 2012 (excluding limited re-analyses as requested). This contract completed within time and on budget. Pressed pellets and water samples were returned by the contractors to GSI at the end of the contract for archiving. Analysis of stream sediments for precious metals including gold was completed between March and July 2013 by Activation Laboratories Ltd. in Ontario, Canada.

In addition, the contractors collected vegetation samples during the geochemical survey. These have been useful for specific research, but have not been processed by Tellus Border for the project area.

Finding: 22. The geochemical data collection was a success – the data was collected as per schedule, to the required standard, more data was collected than planned for/funded (with the inclusion of additional vegetation samples), and there were no major issues with landowners, farmers or the general public.

Finding: 23. The project's overall strategy for processing the data collected was a sound one:

- Pre-processing by the contractor responsible for data collection included their own quality control processes
- The project was responsible for quality assurance and data processing with some support from BGS
- There was a clear audit trail from data receipt to release (including very detailed weekly reports on activities)
- The processing approach was set out in clear, detailed and timely technical reports

This approach worked extremely effectively.

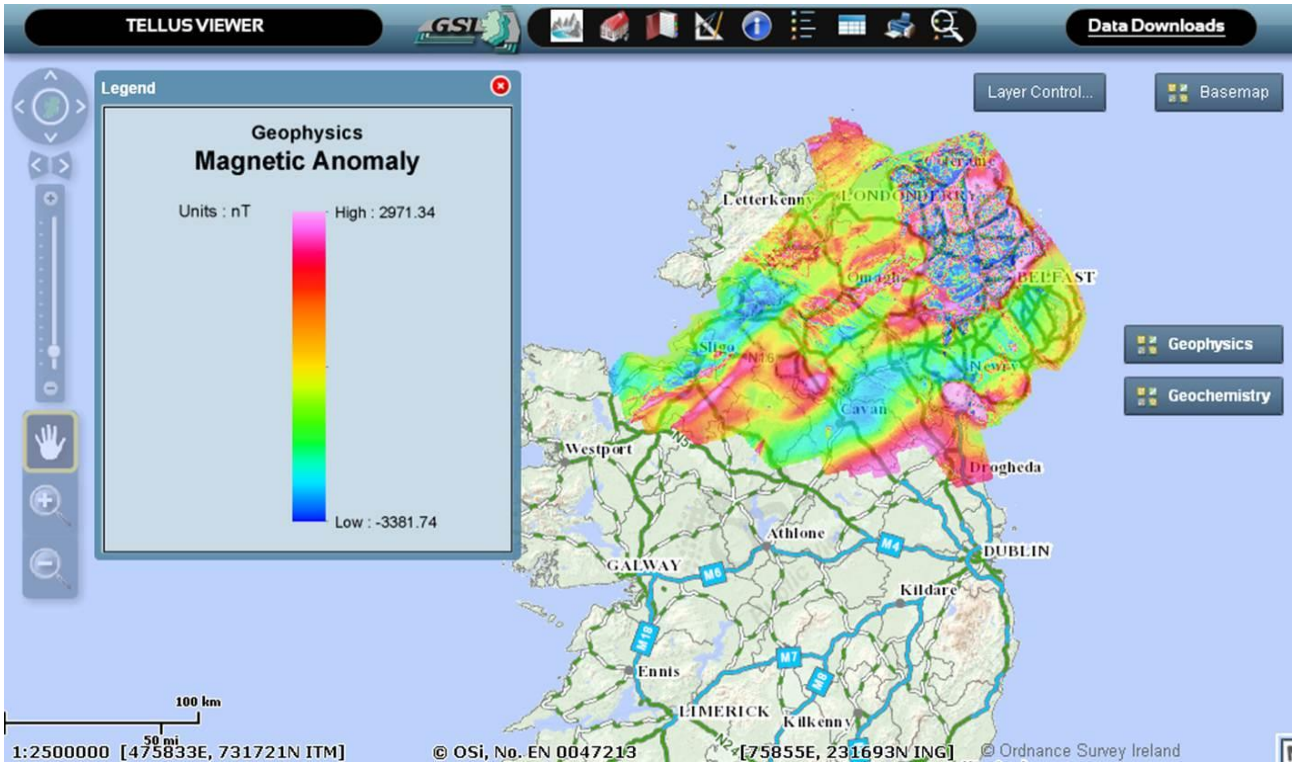
The table below sets out the geochemical survey timeline.

Event	Date
Issue of tender: soil sampling	June 2011
Issue of tender: water/sediment sampling, prep & analysis	December 2011
Survey fieldwork – soil	August 2011 – January 2012
Survey fieldwork – drainage	August – October 2011 & February – May 2012
Soil preparation	June – September 2012
Soil analysis	July – October 2012
Sediments preparation	April – July 2012
Sediments analysis	June – October 2012
Water analysis	April 2012 – November 2012
Tender and analysis for precious metals	March – July 2013
Publication of results/reports	February 2013, June 2013, October 2013

4.2.2 Data provision

Having collected the data, quality assured it and processed it, the Tellus Border project made the data freely available via the project website (www.tellusborder.eu). Data provision was either:

- Through the browser-based Tellus Border viewer (as shown below). This allowed users who did not have access to GIS software to view the data and undertake basic manipulation.



- Through raw data downloads, which allowed users with Geographic Information Systems (GIS) to manipulate and view the data in a way that suited their needs best. Data was provided in a common industry standard (.SHP files) associated with market-leading GIS software (ESRI's ArcGIS). Freely available data translators allow data in this format to be used by other GIS common platforms (e.g MapInfo)

- Through webservices, which allow for data integration with desktop applications and for further redevelopment into third party websites and applications. These webservices are a link to the DCENR web server, and are provided in a number of open standards (WMS, KMZ).

The Tellus Border data was made available for download and re-use freely and openly under the Irish Public Sector Information (PSI) license. Further, there was no need to sign a licence before the data was accessed – it was available immediately on the website. There is no requirement to provide contact details or e-mail address to access the data.

This was completely different to the Tellus project, whilst free under licence to academic users, NI government policy required industry users to both sign a licence and pay for data access. This free-to-access approach was seen by many stakeholders as "revolutionary"[19] and undoubtedly contributed to the wider access and use of the data. Statistics for the Tellus Border website revealed:

- 16,414 unique visits to the main site and 81,564 page views[20]
- 3,366 unique visits to the viewer and 33,570 page views[21]
- 2,267 data downloads.[22] Note that once the data is downloaded, it is possible for parties to use it many times and/or send on to other parties. Thus 2,267 downloads does not give an indication of how often and widespread the data are being used.

By way of comparison, in the first year the Tellus data was available, 8 private companies, 10 Government organisations and 10 university research projects accessed the Tellus data.

Finding: 24. By making the Tellus Border project data freely available (both to download or via the viewer), the project has managed to disseminate the data significantly more widely than the Tellus project – this was something that stakeholders saw as extremely successful.

There was no data collected on who downloaded or used the data, what they were seeking to do with the data, how often they used the data and the value they derived from the data. Monitoring data downloads, web map viewer access and web services would have involved a more costly solution, though it would have provided data on who was downloading the data. It could be countered that open access helps build trust, where the Government is providing data to the public without "tracking" - this could be important in contentious subject areas such as fracking.

The project did undertake two surveys at major stakeholder events (Data Launch, February 2013 and Results and Research Conference, October 2013) to understand the benefits and economic value of the data and to collect any feedback that users wanted to provide about on how future Tellus datasets might be improved. Accepted that the overall approach to releasing the data was defined by the Irish Government policy (and not by the project) and that through the communications exercises the project has an idea as to who some of the users are, however the absence of comprehensive metrics on the current audience is ultimately a weakness.

Finding: 25. The mechanism of data provision (specifically not requiring those using the browser or downloading the data to provide their details) means that basic and valuable intelligence on the user community has not been gathered – there is no traceability as to who the users are and how they are using the data. While this has been offset to some extent by the widespread stakeholder engagement, the project team "don't know who they don't know."

Integration of the original Tellus dataset with the Tellus Border set is possible, however until very recently users have had to pay for a licence for the Tellus data in Northern Ireland. All stakeholders indicated that the freely available nature of Tellus Border is one of its most highly desirable features,

[19] Based on feedback given during stakeholder interviews conducted in April 2014 by PA Consulting

[20] Google analytics report provided by Project team for 24 June 2011 to 18 March 2014

[21] Google analytics report provided by Project team for 1 February 2013 to 18 March 2014

[22] As provided by the Project Team for data to 18 March 2014

and some stakeholders highlighted that this legacy licence issue is causing delays or reductions in the use of the combined datasets. From the 1st April 2014, Tellus data (Northern Ireland) was available at no charge.

Finding: 26. Making the Tellus and Tellus Border project available as a single combined dataset seems a logical step and one that would be welcomed by many stakeholders. From a user perspective (and providing that licence issues can be overcome) this would have minimal implications for data analysis but would significantly increase the scope and usefulness of the data.

Following the successful completion of the surveys, the work of the project communications workstream shifted onto supporting the release of the data and the potential geo-environmental benefits of the data to cross-border stakeholders in central and local government, industry, agriculture and academia.

Rather than wait until all datasets were available, the project undertook a phased data release. This was welcomed by stakeholders, particularly those in the private sector, who were keen to access the data as soon as possible. As well as interim data release, there was also a major launch event (which received significant media attention, including 39 newspaper articles and three national TV news features) when the full data was available. The phased release of data supported continued interest in the Tellus Border project to be maintained.

Finding: 27. The phased release of datasets worked well, creating multiple communications opportunities to reinforce the Tellus Border approach, data and stakeholder interest.

In terms of benchmarking the quality and value of the data internationally, this is extremely difficult to do. The most useful proxy is the Fraser Institute's annual survey[23] of mining and mineral exploration companies worldwide. Responses from 742 mining-related companies worldwide showed that the quality of Ireland's geological databases are considered 2nd in the world (based on quality and scale of maps, ease of access to information, etc.) to support investment in the area. This was up from 17th in 2012 and comes after the successful completion of the Tellus Border project.

Finding: 28. An annual international mining survey demonstrates that mining companies see the value of the Tellus Border project and that the quality and accessibility of the data strongly supports investment in the area.

4.2.3 Research papers

One of the specific objectives of the Tellus Border project was to undertake innovative environmental research. Specifically the project would:[24]

"Undertake environmental studies using these data that will inform management practices and disseminate the results at all levels. (Completion by month 36). These studies or tasks will include:

- *Soil and stream chemical characterisation of cross-border catchments*
- *Delivery of data required by the (expected) Soil Framework Directive, the Water Framework Directive and the Nitrates Directive, Framework Convention on Climate Change*
- *Hydrological, hydrogeological and hydrochemical characterisation of representative wetlands*
- *Mapping of groundwater pollution plumes from isolated waste sites*
- *Estimation of peat depths, based on attenuation of airborne radioactivity and GIS/geostatistics (which contributes to carbon inventory calculations)*
- *Detailed areal mapping of levels of natural and artificial radioactivity.*

[23] Fraser Institute Annual Survey of Mining Companies, 2013

[24] Tellus Border project Application Form (Part B), GSNI (July 2009) Section 2.3.3

Deliverables for these research projects will include, for each study, at least two peer-reviewed scientific publications and the mounting of a mobile public exhibit and information display."

Appendix C shows the extensive volume of research papers that were produced by the Tellus Border project. In addition three post-doctorate research projects have been undertaken:

- Ecohydrological characterisation of wetlands in the border region (DkIT)
- Monitoring Groundwater Contaminant Plumes using Airborne Geophysical Data (QUB)
- Soil Carbon and Peat Depth Assessment using Airborne Geophysical Data (QUB).

A further research output published by UCD is also available on the Tellus Border site: Fault Analysis Group, UCD (2013) Quantitative analysis of Cenozoic structures from the Tellus Border dataset.

Finding: 29. The project has created a significant amount of research material based on the Tellus and Tellus Border data.

Further, once the project started, SEUPB permitted the reclassification of overhead expenditure to programme costs during the course of the project to enable the creation of mini-research projects. These were awarded after a tendering process and comprised the following activities:

a. Tellus investigation of wetland ecology and geochemistry. Principal investigators Dr Ray Flynn, Queen's University Belfast and Dr Valerie McCarthy, Dundalk Institute of Technology

b. A preliminary prospectivity map for the Tellus Border region. Principal investigator Dr Sarah Coulter, Omagh Minerals

c. Groundwater and land resources in Tellus Border coastal zones. Principal investigators Dr Eve Daly and Yvonne O'Connell, NUI Galway

d. Twig epiphyte communities as indicators of environmental quality in the border region of Ireland. Principal investigator Howard Fox

e. Critical Metal potential of the Mourne Mountains: the geological source of Rare Earth Elements, Nb, Ta, W and U anomalies - insights from Tellus data. Principal investigator Dr Katherine Moore, University of Exeter

f. Determination of stream sediment background concentrations in mineralised catchments impacted by mining using Tellus data from Northern Ireland. Principal investigator Dr Barbara Palumbo Roe, British Geological Survey

g. Refining the Human Health Risk Assessment Process from Soil Contaminant Exposure: Trace Element Bioaccessibility and Normal Background Concentrations in NI/Irish Soils. Principal investigator Dr Ulrich Ofterdinger, Queen's University Belfast

h. A geochemical approach to unravelling ice sheet history using both Tellus and Tellus Border soil geochemical data. Principal investigator Dr Paul Dunlop, Innovation Ulster Ltd

i. Application of the Tellus Border soil chemistry data to the Agricultural Sector in Ireland. Principal investigator Dr Chris Johnson, British Geological Survey

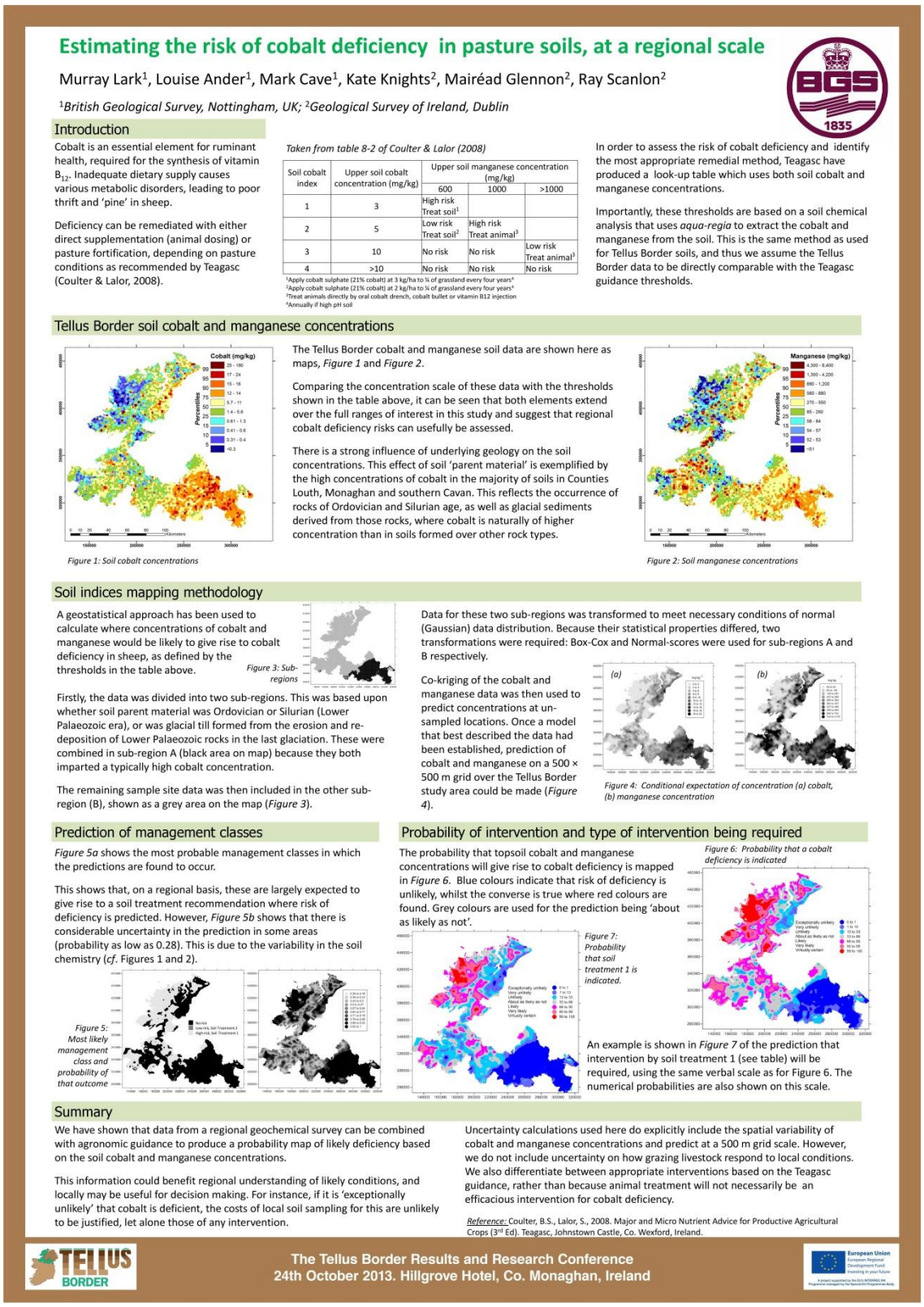
j. Discriminating diffuse anthropogenic input of selected contaminants to soil in the Tellus Border area. Principal investigator Dr Mark Cave, British Geological Survey

k. Quantitative analysis of Cenozoic structures from the Tellus Border dataset. UCD report, Fault Analysis Group, UCD (2013)

l. Mining Impact on Stream Sediment Quality in County Antrim, Northern Ireland. British Geological Survey Commissioned Report, Lass-Evans, S. (2013).

Finding: 30. The ability to re-route funding that would otherwise have been lost to the project to ten different areas of research has created value added activity and highlighted specific case studies for future research to build upon.

All finalised research papers are available on the Tellus Border website. Further, for each research paper a poster summary was produced, for example as shown below. The intention of these was to summarise the key findings in an accessible way.



Estimating the risk of cobalt deficiency in pasture soils, at a regional scale

Murray Lark[1], Louise Ander[1], Mark Cave[1], Kate Knights[2], Mairéad Glennon[2], Ray Scanlon[2]

[1]British Geological Survey, Nottingham, UK; [2]Geological Survey of Ireland, Dublin

Introduction

Cobalt is an essential element for ruminant health, required for the synthesis of vitamin B_{12}. Inadequate dietary supply causes various metabolic disorders, leading to poor thrift and 'pine' in sheep.

Deficiency can be remediated with either direct supplementation (animal dosing) or pasture fortification, depending on pasture conditions as recommended by Teagasc (Coulter & Lalor, 2008).

Taken from table 8-2 of Coulter & Lalor (2008)

Soil cobalt index	Upper soil cobalt concentration (mg/kg)	Upper soil manganese concentration (mg/kg)		
		600	1000	>1000
1	3	High risk Treat soil[1]		
2	5	Low risk Treat soil[2]	High risk Treat animal[3]	
3	10	No risk	No risk	Low risk Treat animal[3]
4	>10	No risk	No risk	No risk

[1]Apply cobalt sulphate (21% cobalt) at 3 kg/ha to ¼ of grassland every four years[4]
[2]Apply cobalt sulphate (21% cobalt) at 2 kg/ha to ¼ of grassland every four years[4]
[3]Treat animals directly by oral cobalt drench, cobalt bullet or vitamin B12 injection
[4]Annually if high pH soil

In order to assess the risk of cobalt deficiency and identify the most appropriate remedial method, Teagasc have produced a look-up table which uses both soil cobalt and manganese concentrations.

Importantly, these thresholds are based on a soil chemical analysis that uses *aqua-regia* to extract the cobalt and manganese from the soil. This is the same method as used for Tellus Border soils, and thus we assume the Tellus Border data to be directly comparable with the Teagasc guidance thresholds.

Tellus Border soil cobalt and manganese concentrations

The Tellus Border cobalt and manganese soil data are shown here as maps, *Figure 1* and *Figure 2*.

Comparing the concentration scale of these data with the thresholds shown in the table above, it can be seen that both elements extend over the full ranges of interest in this study and suggest that regional cobalt deficiency risks can usefully be assessed.

There is a strong influence of underlying geology on the soil concentrations. This effect of soil 'parent material' is exemplified by the high concentrations of cobalt in the majority of soils in Counties Louth, Monaghan and southern Cavan. This reflects the occurrence of rocks of Ordovician and Silurian age, as well as glacial sediments derived from those rocks, where cobalt is naturally of higher concentration than in soils formed over other rock types.

Figure 1: Soil cobalt concentrations

Figure 2: Soil manganese concentrations

Soil indices mapping methodology

A geostatistical approach has been used to calculate where concentrations of cobalt and manganese would be likely to give rise to cobalt deficiency in sheep, as defined by the thresholds in the table above.

Figure 3: Sub-regions

Firstly, the data was divided into two sub-regions. This was based upon whether soil parent material was Ordovician or Silurian (Lower Palaeozoic era), or was glacial till formed from the erosion and re-deposition of Lower Palaeozoic rocks in the last glaciation. These were combined in sub-region A (black area on map) because they both imparted a typically high cobalt concentration.

The remaining sample site data was then included in the other sub-region (B), shown as a grey area on the map (*Figure 3*).

Data for these two sub-regions was transformed to meet necessary conditions of normal (Gaussian) data distribution. Because their statistical properties differed, two transformations were required: Box-Cox and Normal-scores were used for sub-regions A and B respectively.

Co-kriging of the cobalt and manganese data was then used to predict concentrations at un-sampled locations. Once a model that best described the data had been established, prediction of cobalt and manganese on a 500 × 500 m grid over the Tellus Border study area could be made (*Figure 4*).

Figure 4: Conditional expectation of concentration (a) cobalt, (b) manganese concentration

Prediction of management classes

Figure 5a shows the most probable management classes in which the predictions are found to occur.

This shows that, on a regional basis, these are largely expected to give rise to a soil treatment recommendation where risk of deficiency is predicted. However, *Figure 5b* shows that there is considerable uncertainty in the prediction in some areas (probability as low as 0.28). This is due to the variability in the soil chemistry (*cf.* Figures 1 and 2).

Figure 5: Most likely management class and probability of that outcome

Probability of intervention and type of intervention being required

The probability that topsoil cobalt and manganese concentrations will give rise to cobalt deficiency is mapped in *Figure 6*. Blue colours indicate that risk of deficiency is unlikely, whilst the converse is true where red colours are found. Grey colours are used for the prediction being 'about as likely as not'.

Figure 6: Probability that a cobalt deficiency is indicated

Figure 7: Probability that soil treatment 1 is indicated.

An example is shown in *Figure 7* of the prediction that intervention by soil treatment 1 (see table) will be required, using the same verbal scale as for Figure 6. The numerical probabilities are also shown on this scale.

Summary

We have shown that data from a regional geochemical survey can be combined with agronomic guidance to produce a probability map of likely deficiency based on the soil cobalt and manganese concentrations.

This information could benefit regional understanding of likely conditions, and locally may be useful for decision making. For instance, if it is 'exceptionally unlikely' that cobalt is deficient, the costs of local soil sampling for this are unlikely to be justified, let alone those of any intervention.

Uncertainty calculations used here do explicitly include the spatial variability of cobalt and manganese concentrations and predict at a 500 m grid scale. However, we do not include uncertainty on how grazing livestock respond to local conditions. We also differentiate between appropriate interventions based on the Teagasc guidance, rather than because animal treatment will not necessarily be an efficacious intervention for cobalt deficiency.

Reference: Coulter, B.S., Lalor, S., 2008. Major and Micro Nutrient Advice for Productive Agricultural Crops (3rd Ed). Teagasc, Johnstown Castle, Co. Wexford, Ireland.

The Tellus Border Results and Research Conference
24th October 2013. Hillgrove Hotel, Co. Monaghan, Ireland

A number of stakeholders highlighted that the key message of posters could be missed to the lay-reader as there is still a preponderance of technical language. GSI and GSNI together with their stakeholders (e.g. Teasgasc, farm advisors, RPII) may be missing an opportunity to engage the wider audience by deploying "jargon-free" summaries of the key findings of the research to ensure the

salient points are understood by those without technical background. This is not a criticism of the materials produced to date; rather that more could be done (as part of the legacy of the Tellus Border project) to take the outputs and convert into more user-friendly materials.

Finding: 31. The project has made available all research papers together with poster summaries through the website together with summaries. The nature of the subject matter is very technical and does not lend itself easily for the casual, non-technical browser. There is a gap here that is currently not addressed – some stakeholders wanted a simple, non-technical, one sentence summary of each paper that explained the wider relevance of each analysis.

4.2.4 Stakeholder engagement

The basis for stakeholder engagement on the Tellus Border project was a communications strategy developed at the project inception. This built upon the success of the Tellus project. Its aims were to:

- Plan and execute activities to meet the needs of the stakeholders
- Maximise public interest in the Tellus Border data collection
- Warn landowners and other affected groups of the survey operations and its purpose
- Inform relevant media organisations and collaborate with appropriate user organisations
- Inform government, academic and commercials organisations of the value and timing of the data being collected.

The key highlights of the communications deliverables that ensured this success were:

- Engagement of a specialist PR Company, Morrow Communications via open tender
- Monitoring of local and national media coverage and utilising same for distributing messages and updates en masse
- Provision of email and telephone help facilities for the general public and distribution of a FAQ document to further aid common queries
- Local, regional and national stakeholder engagement
- Flyer and poster notifications prior to airborne surveys, followed up with targeted landowner engagement
- Creation and distribution of 6 newsletters during the project
- An open day, data collection launch and closure event and a final data presentation launch event.

Stakeholder meetings continued throughout the data collection, analysis and presentation stages of the project, with many stakeholders commenting that the continual awareness of the campaign has greatly increased the likelihood of Tellus Border delivering valuable research and commercial activity in the future.

Reflecting the experience gained on the Tellus project, stakeholder management and engagement was seen at the outset as critical to the success of the Tellus Border project. The stakeholders cover two key (though not mutually exclusive) groupings:

- Those directly affected by the surveys during data collection. These individuals might react adversely or be affected by the low-flying plane (undertaking the geophysical data collection) or be worried by people collecting samples from their land. These stakeholders included:
  - Farmers
  - Landowners
  - Animal owners, in particular horse owners
  - Community organisations
  - Local Garda
  - Members of the public in or passing through the area of data collection
  - Special interest groups

- Potential and actual users of the data:
  - Academic, including universities for both research and teaching purposes
  - Commercial organisations or individuals, seeking to exploitation of the data for commercial exploration, agricultural and health uses
  - Local and national government, using the data to assist policy decisions and supporting government processes in land planning, waste disposal, health, etc.
  - Members of the general public.

The role of the communications workstream in supporting data collection and mitigating the risks associated with it was addressed in Section 4.2.1. This review highlighted that engagement with and communications to those directly affected by the surveys was undertaken very successfully – this was evidenced by stakeholder feedback, receptiveness to the data being collected and the ultimately low level of complaints (30 in total) encountered during the surveys. Of worthy mention was:

- The positive feedback that utilising agricultural consultants for the ground surveys engendered a high level of willingness to use the eventual data amongst the farming community
- The targeted approach to identifying specific people affected by each aerial campaign to ensure no major controversy was caused.

> *Mineral exploration has been stimulated based on the anticipation factor, and the sector needed something to stimulate it"*
>
> Mark Holdstock, Aurum Resources

In terms of feedback from potential and actual users of the data, the **academic community** indicated that it felt highly engaged from the outset of the project and commendations were given for the ability to generate the 10 research projects once the data was available. A number of institutions within Ireland have indicated that the data is now forming part of curriculum going forward in specific geography and geochemical modules. Research work is felt to be supported via the website viewer and open source download facility. The project has also enabled a high level of cross border activity, e.g. between DkIT and QUB.

> *With just 1 economic discovery on the back of Tellus Border data the project will pay for itself a hundred times over"*
>
> Aidan Lavelle, Erris Resources

As part of this exercise a number of academic institutions outside of the island of Ireland were approached. Unsurprisingly, they had significantly less visibility of and barely utilised the data relative to within Ireland-based academics. However the Tellus Border data (large datasets to a high quality) are of interest to the wider international academic community and this could be further exploited.

Consultees within the **commercial sector** (in particular the mineral exploration organisations) believe that they are self-serving with regards to the data – all they wanted to know was when the data would become available and then they would download it to their own GIS platform.

Mineral exploration in Ireland is controlled via Prospecting Licences, which give the holder exploration rights for an area and is valid for six years (with the possibility of renewal). There was feedback that the availability of the Tellus Border data encouraged Prospecting Licences to be taken out. The licence awarding body (DCENR) asks for factors that may have influenced their decision to apply for the licence.

Since the start of the Tellus Border project, 38 new licences have been issued to four separate companies. These licences are directly attributable to Tellus (based on application form question issued by licensing agency). If all 38 licences are held for the full six years the estimated income to the Department would be a minimum of €1.2 million. A further 14 applications are currently being

processed, which have been received since the Tellus Border project was launched. If these are granted and last for six years they will yield a further €300k. Exploration licensing in Ireland is currently at a 22 year high. DCENR highlighted that the border area is having a surprisingly high volume of applications - during 2013, 59% of all prospecting licence applications received by the Exploration and Mining Division were for this region. This is most probably attributable to the Tellus Border project.

It is worth recognising that the economic contribution of the mining and mineral exploration industry to the Irish economy is considerable – in 2012 it had sales of €426m and directly supported 1,373 full-time equivalent (FTE) persons, while an additional 1,933 FTEs were supported indirectly as a result of multiplier impacts throughout the economy.[25] The workforce in the mining industry is broadly distributed across the regions, with the most significant numbers of people employed in the Mid-East, Mid-West and South-East, as well as across other regions in the West and South-West, i.e. not the Tellus Border project area.

Interviews with individuals in the commercial sector indicated that the data facilitated smaller companies to enter the market, with the quality of availability and data eliminating some of the market barriers to entry. A further positive development arose with the request by Aurum Exploration on behalf of Oriel Selection Trust to extend the aerial survey to Mayo and making the results available to Tellus Border. This instance highlights the potential commercial collaboration with the private sector to either extend the geographical coverage of the data, or to conduct more intense surveys and analysis in a specific area, via commercial Research and Development activity in health, agriculture, mineral exploration etc

Feedback from the **government sector** consultees was more mixed. It was universally felt that all the government bodies had been adequately informed of the work, the potential usages in their area and the dates at which the data was available. There does, however, appear to be an issue in how best to enable these departments and local government to exploit the data within their own programmes and policies. A number of interviewees indicated that they felt their own technical capability to exploit the data (both geological and GIS skills) was lacking. Whilst they understood and accepted the potentially high value of the Tellus Border data to their organisation, their own capability gap will mean delayed or under exploitation.

A total of 45 briefing/stakeholder engagement meetings were held with stakeholders during the project lifetime, with over 600 people attending these meetings. These briefings were both to inform interested parties of the survey activities (to help mitigate the risk of complaints/frightening livestock) and to communicate the benefit and potential use of the data. In addition, the project issued a number of press releases (24) to raise public awareness - these resulted in over 12 million opportunities to hear about the project. The delivery of the communications workstream was recognised by many stakeholders as exemplary/best practice.

192 newspaper articles	7.5m opportunities to see
60 radio items	2.3m opportunities to see
5 TV programmes	2.3m opportunities to see
Total	**12.2m opportunities to see**

The project presented at 28 scientific conferences, reaching an estimated 2,500 delegates and 30 further events were attended by Tellus Border representatives during the project lifetime including:

- Prospectors and Developers Association of Canada Convention, Toronto (2013) 30,000 delegates
- BT Young Scientist Exhibition, Dublin (2012 and 2013) 5,000 visitors

[25] Assessment of Economic Contribution of Mineral Exploration and Mining in Ireland, Indecon International Economic Consultants, July 2013

- Balmoral Show, Lisburn (2013): 70,000 visitors
- National Ploughing Championships, Laois (2013): 220,000 visitors.

The Tellus Border Project Team also provided input for publications during the project including Inshore Ireland, Earth Science Ireland and Science Spin.

> *Delivery of the communication strategy; was excellent – to local communities and the research and scientific communities. Not just hyping but factual reporting on data and deadlines"*
> Pat Shannon, UCD

There was some (limited) negative feedback in relation to the media approach supporting the launch of the Tellus Border data in Q4 2013, specifically the headline story around gold. The rationale for doing this was sound - grabbing public and political attention with a possibility of gold mining, and then feed in the other benefits from the data in the agricultural, environmental and health areas. This approach, however, caused disagreement with some in the scientific and academic communities. Specifically that this may have unnecessarily alienated some potential users, particularly when the project was funded on the basis of an environmental theme.

The project team reviewed the quality and effectiveness of their communications and stakeholder engagement throughout delivery to provide feedback as to what could be improved. The evaluation covered a detailed assessment of the communications report provided by the project team and verification of its conclusions via interviews with relevant stakeholders/review of the raw data. The project team's assessment of their delivery was consistent with the views of stakeholders and this evaluation – many stakeholders highlighted that the communications strategy deployed was hugely impressive and successful in gaining the necessary support and interest in the project.

Finding: 32. The approach to communications and stakeholder engagement was very professionally structured and delivered. In particular the project continually sought feedback from stakeholders and evidence (including website usage) to learn where elements could be better delivered. This resulted in significant opportunities for the general public, those directly affected by the survey and potential data users to find out about the project, the data collection and the potential data uses.

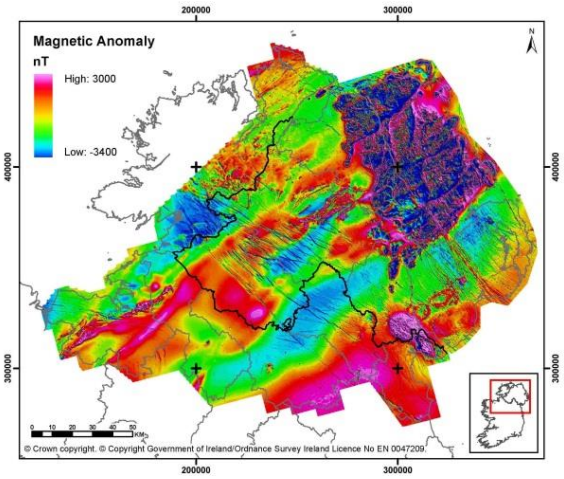
One area that some stakeholders raised indirectly was the poor perception of the mining, extraction and minerals industry from parts of the general public. For example, fracking is a particularly controversial environmental issue at present. This reflects a lack of public understanding as to what the industry does, how it operates and the value of the industry to the island of Ireland. While this does not relate to the delivery of the Tellus Border project, it does highlight an issue around maximising the benefits from Tellus Border data.

It is worth highlighting that in spite of public concerns around extraction (in particular fracking), the Tellus Border project still managed to complete the data collection – a risk was that a fear of the potential for fracking might encourage a backlash against the data collection. Through carefully managed communications, this was not the case. Furthermore, the data could be used as a baseline to measure environmental changes should fracking take place. The table over sets out the communications timeline.

> *We have been very impressed by both the outputs of the project and with the lengths to which the partners went to inform stakeholders about it."*
> Michael Curran, Louth County Council

Event	Date
PR Contract – advertisement and appointment	March 2011
Newsletter	6 issued – July & December in each of 2011 - 2013
Website Live	24th June 2011
Publication of final metrics on website	24th October 2013
Co-ordinated Ministerial launches	February 2011
Council and major stakeholder briefings	February 2011 – June 2011 & October – December 2013
Airborne survey launch day	March 2012
Geochemical – last sample ceremony	June 2012
Annual technical seminars	July 2011, November 2012, November 2013
Data launch	February 2013
Attendance at agricultural shows	May & September 2013
Communications programme report	March 2014
Final results and research conference	October 2013

4.2.5 Project outputs



> *Tellus Border is a great dataset, already embedded in teaching processes and which allows fantastic potential for future exploitation and value"*
> Eve Daly, NUI Galway

By the end of the project the Tellus Border project had delivered the following outputs to date:

- A website providing free browsing and download of the geophysical and geochemical datasets
- Three post-doctoral research studies (for each of wetlands; carbon in soil and pollution plumes)
- Two databases; multi-element soil geochemistry; and magnetic field, electrical conductivity and radioactivity
- Two sets of maps; one covering soil geochemistry; and magnetic field, electrical conductivity and radioactivity maps
- 25 research papers published in peer reviewed journals and more than 25 conference abstracts
- Two University-level field courses (1 for geophysics and 1 for geology)
- Four university workshops and content for two modules.

4.3 Delivery against original objectives

The table over highlights areas where the project has not fully evidenced completion against the funding requirements. All the outputs and results are complete. In terms of impacts, these may have been achieved in part but there is limited evidence to confirm this. In practice these impacts were not appropriate targets.

Output	Result	Impact
✓ 1 environmental management project funded - *completed* ✓ 7,475km² land geophysical surveyed – *10,426km²completed* ✓ 12,312km² land geochemical surveyed – *12,339km² completed* ✓ 1 project website developed - *completed. Went live in 2011 and verified during evaluation* 3 post-doctoral research studies ✓1 on wetlands – *poster presented and final report* ✓1 on carbon in soil - *poster presented and final report issued* ✓1 on pollution plumes *poster presented and final report issued*	✓ 2 sets of digital databases developed, 1 multi-element soil and stream geochemistry database and 1 magnetic field, electrical conductivity and radioactivity database – *both complete* ✓ 2 sets of maps developed, 1 multi-element soil and stream geochemistry maps and 1 magnetic field, electrical conductivity and radioactivity maps – *both complete and available under the Tellus viewer* Disseminate results of research through: ✓ 8 publications in peer-reviewed journals 2 at project level and 6 for research papers – *25 papers on Tellus Border and Tellus data published since April 2010* ✓2 annual technical seminars - *completed* ✓1 end project conference - *completed* ✓6 presentations to councils – *15 undertaken* ✓1 roadshow/exhibition - *completed* University level field courses developed for project	✓ Knowledge and sharing of skills promoted, measured through project by increased number of people capable of surveying and project partners networking – *completed. Strong indications that the Tellus Border project has enabled cross discipline working* ✓ Best practice promoted and supported, measured internally by project through recommendations from reports – *completed. Research findings being shared through website* 😐 Increased public awareness of the science, the importance and the process of sustainable management of soils and waters – not a full evidence trail. The website metrics and the large number of "opportunities to see" show interest; however the project cannot measure where the interest is coming from to verify that the public awareness nor adequately baseline interest. ✓ Policies at national level using databases - data is being used in a number of areas, for example in the National Radon Control Strategy ✓Local and national research using data –.academic institutions are beginning to utilise the data in undergraduate teaching and that the data will become a core part of the future curriculum for future courses. In practice this impact will take a number of years to materialise.

4.4 The legacy of Tellus Border (and Tellus)

The Tellus Border was surveyed over 2011-2012, the data was processed and quality assured and then released for free access from 2013. The project funded post-doctorate research is complete with all three final reports now available on the Tellus Border website. In addition 10 further mini-research projects were funded by the project, after SEUPB approved the transfer of funding during the project. All ten of these papers were presented in poster format at the Tellus Border launch, with six of the final reports now available on the website.

Academic institutions highlighted that research will definitely continue, although at this stage it is very difficult to evaluate this numerically. The wider geochemical and geophysical teaching programmes are being greatly assisted by the data and data viewer, enabling a more effective teaching method and potentially leading to a higher retention of students within their discipline. The health and agricultural

sectors have already expressed a high degree of interest in utilising the data in specific research activity and it is clear therefore that further benefits will accrue into the future.

Finding: 33. The Tellus Border project, as defined in its original funding application, is to all intents and purposes complete. The Tellus Border (and indeed Tellus) data, however, has a value that does not stop when the project stops nor does it significantly decline over time – the underlying geology of the earth stays the same. Therefore benefits will continue to accrue over a number of years. While GSI have provided short term funding in 2014, there is no long term continuity of resources to continue to help drive out these benefits.

A key question is therefore how best to help continue to drive out the benefits from the Tellus Border (and Tellus) projects. Feedback from stakeholders highlighted the following issues:

- There is still a significant challenge with local and national Government bodies – within most relevant organisations they know about the Tellus Border data but:
  - In some cases they are unclear as to how they can derive value. Sometimes Tellus Border reports are seen to be too technical or how the data were collected and do not tell a simple, yet compelling story as to how the data can be used to, for example, reduce costs
  - Understanding of the Tellus Border project value often resides with technical staff. As a technical project, Tellus Border has typically engaged with technically minded individuals within an organisation. The project has sought to engage with non-technical staff, but this has often proven to be challenging
  - Other technical issues stand in the way. In many cases Tellus Border data is one part of a wider solution, which includes GIS software and other data sources

> *"We don't currently have the ability to utilise the data fully, as we lack the in-house, in-depth expertise in terms of geophysics and geochemistry. Perhaps a training course for all planning and environmental staff would help us understand what Tellus data can do for us and allow us to maximise its value."*
> Michael Curran, Louth County Council

- Commercial and research organisations will continue to exploit the data, but there are likely to be a number of potential users who are unaware of the data (in Ireland and internationally). Awareness of the Tellus Border data in the mining sector is high. And they are also aware of its potential. But it is likely that other sectors are less familiar with the existence of the data and how it could be used. Here a simple, compelling story as to how the data can be used would be helpful
- Bringing together the Tellus and Tellus Border datasets into one (free) source would immediately provide wider opportunities for some (but not all) organisations

Finding: 34. There are a number of wider factors which are preventing full benefit realisation from the Tellus Border project. These lie outside the control of the project team at present, though the team are doing their best to help them as appropriate.

Consultees strongly supported **extending the data coverage geographically to a national level**. This could be incremental, with specific surveys in certain areas with a high dependency on, for example, agriculture or into more densely populated areas which could provide verification of theoretical research to date. The belief is that the current dataset is world leading in terms of quality, but an extension across the country would help realise the benefits of existing data. This is particularly true for national bodies, where national coverage would mean a consistent base dataset could be analysed nationally. For example a body such as the RPII see value in understanding radon prevalence in the border counties. However national analysis would be an extremely powerful tool.

Consistent with extension of the survey nationwide, the possibility exists to **find synergies with comparable offshore surveys around Ireland** and potentially **integrate with other Tellus projects**

namely the Tellus South West and proposed GSI/BGS INTERREG V Ireland-Wales projects. Integration with these would provide researchers and commercial organisations greater visibility of comparable datasets and provides for economies of scale for data processing and analysis. A further way to enhance the legacy of the data would be to **repeat the survey in future** for key elements to support time series analysis. This may be of particular value in the health and environmental sector, to analyse the deterioration of natural resources and determine whether natural or man-made effects are the cause.

Finding: 35. Consultees highlighted support for detailed geological data collection being extended:

- Nationally, to provide a comprehensive data source for Ireland
- Offshore, recognising that geology does not stop at the shoreline
- To include refreshes, to allow time series analysis to be undertaken.

> *"the Tellus Border data and rollout potentially to the rest of the country would create a rush to stake ground in mineral exploration and a high probability that an economic discovery will occur"*
> Aidan Lavelle, Erris Resources

Finding: 36. Consultees also saw merit in combining/integrating the Tellus Border with other Tellus datasets to allow more extensive analysis, to share insight/research, and to enable more coordinated comprehensive communications approach (in particular with international bodies).

All stakeholders commended the project management and technical experiences and skills demonstrated by the Tellus Border project team. Whilst difficult to value the knowledge in monetary measurements, there is undoubtedly a high value of intellectual property that could be utilised and applied to similar surveys elsewhere in UK/Ireland or beyond. Exploitation of this intellectual property could lead to either deployment of staff (for example in an advisory role or steering committee) or development of best practice guidelines and training to be applied for future iterations of a Tellus style project internationally.

Finding: 37. GSI/GSNI have developed capabilities to professionally manage and delivery comprehensive geochemical and geophysical surveys. This could be exploited internationally.

The Project has been highly commended by a number of stakeholders on its unique ability to enable users across the scientific and academic spectrum in collaborative research. The issue on the lack of visibility of users downloading data on the website has already been referenced elsewhere in this report. Some consultees suggested that the Tellus Border project team may consider a forum for scientific, academic and commercial sectors to more easily network directly as a next logical step in ensuring that the value of the data is maximised whilst minimising inputs and removing direct participation by the Project Team overtime, essentially slowly reducing the handholding role.

As there are no obvious social media outlets in existence for discussing specific Tellus related data and exploitation, such a forum would enable users of the data to share ideas and potentially reduce costs on duplicated avenues of research. Researchers and commercial ventures could also potentially be matched by interest and sector via the Tellus forum to further generate value over time. Such a forum was precluded by DCENR and DETI policies during the project's lifetime.

Finding: 38. The project has not to date used a social media discussion forum (due to DCENR and DETI policies) as a means for promoting knowledge sharing associated with the Tellus Border project.

SECTION 5

Conclusions & recommendations

5 CONCLUSIONS & RECOMMENDATIONS

5.1 Key findings

The key findings, as evidenced in the previous two chapters, are as follows:

- **Finding: 1**. The concept of a cross-border geophysical and geochemical survey was one that GSI and GSNI had jointly developed over a number of years. The concept had been worked up using evidence collated from a number of independent technical and economic analyses undertaken by credible parties.
- **Finding: 2.** The successful delivery of the Tellus project (on time, to budget and with the benefits in excess of those projected at that stage) demonstrated that the concept of a widespread geophysical and geochemical survey was realistic, there was a demand for the data and that the underlying technical and economic analyses were appropriate. The application of Tellus to the south west of England by BGS provides further validation of the approach.
- **Finding: 3.** The Tellus Border project was not simply the Tellus project being replicated in another region. Rather it sought to extend the use of existing Tellus data through a number of post-doctoral research projects. Thus while data collection only took place in Ireland, there was a significant cross-border element that built upon one of the key findings of the Tellus project (i.e. that more could be done to exploit the Tellus data that had been collected). Further the Tellus Border project sought to make the data available free of charge – a further difference from the Tellus project.
- **Finding: 4.** The targets for the Tellus Border project were consistent with the project aims and, given the benchmark established by the Tellus project, were credible in terms of scope, timescale and cost.
- **Finding: 5.** The application for the Tellus Border project was built upon the Tellus project - a project that had been effectively delivered and had started to produce the long-term projected benefits. The Tellus Border funding application was well written, comprehensive, evidence-based and extremely credible.
- **Finding: 6.** The economic appraisal and previous lack of private sector funding confirmed the fact that the Tellus Border project (and indeed a widespread geophysical and geochemical survey on the island of Ireland) was truly additional – it would not happen without public sector intervention.
- **Finding: 7.** The project's overall governance structure was relatively simple but appropriate for a project of this magnitude and complexity. It had senior representation from key stakeholders. Further, Steering Committee members were able to provide appropriate guidance to the project team around specific issues. The Steering Committee worked well, had appropriate membership, provided appropriate oversight of project progress and signed-off of key deliverables delivery.
- **Finding: 8.** The objectives for the project agreed at the first Steering Committee meeting differed slightly from the original application, though the changes were immaterial.
- **Finding: 9**. Delivery of Tellus Border project was divided into a set of sensible and logically delineated tasks, each with clearly defined outputs and progress being measured for each task at quarterly Steering Committee meetings.
- **Finding: 10.** The project delivery team was appropriately specified, efficiently established and sufficiently robust to evolve in response personnel changes. The project team brought an impressive and comprehensive combination of skills across geophysical and geochemical surveys, project management, procurement and communications.

- **Finding: 11.** There were no staff retention issues during the delivery of the project – this indicates a very positive operating environment where team members felt valued and enjoyed their work.
- **Finding: 12.** Project management and communication was extremely strong and effective, with team members actively participating in wider communications.
- **Finding: 13.** Overall, the Tellus Border project was managed in a highly efficient and effective manner.
- **Finding: 14.** The project finances were managed in an efficient and effective manner, with appropriate governance and oversight from the Steering Committee. Financial reporting met all funder requirements.
- **Finding: 15.** Strong project and financial management allowed the project to rapidly exploit opportunities, for example when SEUPB identified unspent funds in their INTERREG IVA budget.
- **Finding: 16.** In spite of potential for issues relating to complex and technical specifications, the use of external contractors was a success on this project. These contractors were able to provide added value, in particular in their relationship with certain stakeholders.
- **Finding: 17.** The nature of airborne data collection involved a degree of risk, including from factors outside the contractor's control. In practice this meant that the data collection was delayed slightly and took longer than scheduled. While this was an issue at the time, in the wider context this higher risk data collection element was completed without significant incident.
- **Finding: 18.** There was a weekly feedback to the contractor on the geophysical data received, providing robust and timely assurance as to data quality. These seemed to operate effectively with data collected to the required standard.
- **Finding: 19.** The communications strategy and its delivery effectively helped mitigate the risk of major claims for damage to livestock and avoid any negative publicity.
- **Finding: 20.** The project benefitted from a private company undertaking a small survey in an adjacent area, extending the overall coverage of the geophysical survey against the original specification at no cost to the project. This would not have happened without significant goodwill between the private company and the project.
- **Finding: 21**. The geophysical data collection was a success – more data was collected than planned for/funded (with the inclusion of a private sector data set), the data was collected to the required standard and there were no major issues with landowners, farmers or the general public.
- **Finding: 22.** The geochemical data collection was a success – the data was collected as per schedule, to the required standard, more data was collected than planned for/funded (with the inclusion of additional vegetation samples), and there were no major issues with landowners, farmers or the general public.
- **Finding: 23.** The project's overall strategy for processing the data collected was a sound one:
  - Pre-processing by the contractor responsible for data collection included their own quality control processes
  - The project was responsible for quality assurance and data processing with support from BGS
  - There was a clear audit trail from data receipt to release (including very detailed weekly reports on activities)
  - The processing approach was set out in clear, detailed and timely technical reports

  This approach worked extremely effectively.
- **Finding: 24.** By making the Tellus Border project data freely available (both to download or via the viewer), the project has managed to disseminate the data significantly more widely than the Tellus project - this was something that stakeholders saw as extremely successful.
- **Finding: 25.** The mechanism of data provision (specifically not requiring those using the browser or downloading the data to provide their details) means that basic and valuable intelligence on the user community has not been gathered – there is no traceability as to who the users are and how

they are using the data. While this has been offset to some extent by the widespread stakeholder engagement, the project team "don't know who they don't know."

- **Finding: 26.** Making the Tellus and Tellus Border project available as a single combined dataset seems a logical step and one that would be welcomed by many stakeholders. From a user perspective (and providing that licence issues can be overcome) this would have minimal implications for data analysis but would significantly increase the scope and usefulness of the data.
- **Finding: 27.** The phased release of datasets worked well, creating multiple communications opportunities to reinforce the Tellus Border approach, data and stakeholder interest.
- **Finding: 28.** An annual international mining survey demonstrates that mining companies see the value of the Tellus Border project and that the quality and accessibility of the data strongly supports investment in the area.
- **Finding: 29.** The project has created a significant amount of research material based on the Tellus and Tellus Border data.
- **Finding: 30.** The ability to re-route funding that would otherwise have been lost to the project to ten different areas of research has created value added activity and highlighted specific case studies for future research to build upon.
- **Finding: 31.** The project has made available all research papers together with poster summaries through the website together with summaries. The nature of the subject matter is very technical and does not lend itself easily for the casual, non-technical browser. There is a gap here that is currently not addressed – some stakeholders wanted a simple, non-technical, one sentence summary of each paper that explained the wider relevance of each analysis.
- **Finding: 32.** The approach to communications and stakeholder engagement was very professionally structured and delivered. In particular the project continually sought feedback from stakeholders and evidence (including website usage) to learn where elements could be better delivered. This resulted in significant opportunities for the general public, those directly affected by the survey and potential data users to find out about the project, the data collection and the potential data uses.
- **Finding: 33.** The Tellus Border project, as defined in its original funding application, is to all intents and purposes complete. The Tellus Border (and indeed Tellus) data, however, has a value that does not stop when the project stops nor does it significantly decline over time – the underlying geology of the earth stays the same. Therefore benefits will continue to accrue over a number of years. While GSI have provided short term funding for 2014, there is no long term continuity of resources to continue to help drive out these benefits.
- **Finding: 34.** There are a number of wider factors which are preventing full benefit realisation from the Tellus Border project. These lie outside the control of the project team at present, though the team are doing their best to help them as appropriate.
- **Finding: 35.** Consultees highlighted support for geological data collection being extended:
  - Nationally, to provide a comprehensive data source for Ireland
  - Offshore, recognising that geology does not stop at the shoreline
  - To include refreshes, to allow time series analysis to be undertaken.
- **Finding: 36.** Consultees also saw merit in combining/integrating the Tellus Border with other Tellus datasets to allow more extensive analysis, to share insight/research, and to enable more coordinated comprehensive communications approach (in particular with international bodies).
- **Finding: 37.** GSI/GSNI have developed capabilities to professionally manage and delivery comprehensive geochemical and geophysical surveys. This could be exploited internationally.
- **Finding: 38.** The project has not, to date, used social media discussion forum (in part due to DCENR and DETI policies) as a means for promoting knowledge of and sharing best practice associated with the Tellus Border project.

Against the post-project evaluation terms of reference, the following summary observations are relevant:

- Explain the strategic context of the project - this is clearly established in section 3 of this document and findings 1 and 3. There was a clear rationale for the project, based on a scoping study and economic appraisal, and this rationale was clearly carried forward into the project plan and deliverables
- Outline the rationale, aims and objectives of the project - again this is clearly established in section 3 of this document and in findings 4 and 8. There was a clear rationale for the project, based on a scoping study and economic appraisal, and this rationale was carried forward into the project plan and deliverables
- Assess achievement of objectives in relation to timeliness and expenditure as per Letter of Offer - finding 21, 22, 23, 24 and 29 highlighted that the project produced the outputs to the required quality and timescale and within the agreed budget
- Assess project management and control - findings 7, 10, 13 and 14 identified that tight project management, controls and governance were applied, that these worked well and they supported the overall delivery of the project
- Interview key stakeholders – over 40 key stakeholders were interviewed as part of this review. Findings from the consultation process were corroborated where possible with the project team and project documentation
- Assess risk management - finding 12 highlighted that the project management and controls worked well and supported the overall delivery of the project. At the outset, the project team had a good understanding of delivering this type of project (having delivered the Tellus project) and therefore had an excellent appreciation of the risks and issues. These were articulated as part of the project plan and actively managed and monitored throughout the duration of the project. The key risk, relating to adverse publicity/damage to livestock because of the aerial survey, was managed through the communications campaign
- Define assumptions, identify side effects and distribution effects - the situation prior to the release of the Tellus data provides a sound base case against which to analyse assess additionality and displacement - there is no evidence to suggest that a Tellus-type project would have been undertaken without public funding, either on a different scale or at some time in the future. While surveys are undertaken by private sector organisations as part of the exploration process, these are very limited and do not provide the range or coverage of data provided by Tellus Border project. Findings 28 and 29 above identify that there has been a significant increase in the number of commercial exploration licence applications since the Tellus Border data was made available
- Overall assessment for value for money – the case for funding the Tellus Border project was never based on a financial return, rather it on the wider, long-term impacts of the project. The length of time for benefit realisation will vary across sectors and therefore it is not easy to quantify when benefits will be realised – indeed no attempt was made to do this in either the original cost benefit analysis[26] or the economic appraisal.[27] By way of example as to the timescale for realising benefits, it can take seven years for a company to work through the process from identifying a site for mineral exploration to beginning extraction at that site. At this stage, the post project evaluation has shown that stakeholders recognise the value of the data and are seeking to realise the benefits from it. On a purely project basis, the project realised value for money through close management of finances and open competition for technical services

[26] Cost benefit analysis of a resource & environmental survey of Ireland, Environmental Institute University College Dublin (2001)

[27] Geo-environmental survey of the north of Ireland 'GESI North' - economic appraisal, BDO (June 2010), p56

- Make recommendations for improving Tellus to assist in planning for future phases of Tellus (in particular how Tellus coverage might be extended to the rest of Ireland) and how the data might be further exploited. The consultees made a number of suggestions as to how the Tellus Border project might move forward – these are summarised in findings 31 and 33-38. Full recommendations are set out in Section 5.3.

5.2 Conclusions

Before drawing conclusions on the delivery of the project it is worth reflecting on the scale of the challenge that the Tellus Border project took on:

- First of all, the project team had to plan a major data collection. In an area of more than 12,000km², it had to identify 3,500 sites for soil, water, sediment and vegetation samples. It also had to arrange the route of a survey plane, which would be required to fly for 7 days a week over 38 weeks and survey 57,600km, travelling the equivalent of one and a half times around the world.
- Second, it had to notify potentially affected landowners, farmers and the general public of the dates and times of the surveys and minimise adverse publicity about the surveys
- Thirdly, the team needed to collate, process and analyse an immense volume of data. This included over 50 million geophysical measurements, and analysis from soil, stream water and stream sediments for over 50 geochemical elements which resulted in 750,000 geochemical analyses
- Finally, the team need to engage with a wide range of stakeholders, generate interest in the data and make the data available in a form that could be accessed/used by everyone from layperson through to technical expert.

In the context of these major challenges, the Tellus Border project:

- **Was well scoped and planned, based on a well-thought through concept and an evidenced need**
- **Successfully delivered a complex and demanding data collection exercise in a controlled manner**
- **Operated robust quality control processes to ensure that the data met required minimum standards**
- **Engaged with stakeholders/the wider community through an exemplary communications campaign**
- **Managed the project (including risks and issues) in a proactive and effective manner**
- **More than met the funder's objectives as required in the Letters of Offer**
- **Has started to deliver wider economic and social benefits.**

The project team, Steering committee and the project contractors should be praised for delivering a complex project with substantial risks and challenges in a highly competent and efficient manner:

- **"a *benchmark for project management*"**
- **with a "*significant amount of value added activity accommodated within the overall budget*"[28]**

Significant value has been realised by stakeholders from the data generated by the project, though there continues to be a number of challenge to both quantifying this value and ensuring that full benefits are realised in the long-term. The project team has developed a capacity and competency that could delivery other similar projects.

[28] Discussion with Ciaran Hanna, SEUPB, 10th April 2014

5.3 Recommendations

The Tellus Border project has delivered to the funder's letter of offer and on this basis there are no recommendations about the funded project. A number of recommendations are made about taking the Tellus concept forward and continuing to deliver value from it. Because the Tellus Border project is complete, that these recommendations should be considered by GSNI, GSI, DETINI and DCENR

1. **Communications** – the project has created a wide range of technical papers and research. GSNI and GSI should work with relevant stakeholders (including Government Departments) to create further communication materials which are user-centric rather than technical centric. These will take the concept of the posters, but produce information that focuses very much on the user rather than the data/technical side. For example:
   - "As a farmer, what can you tell me that would help my crops grow better?"
   - "As a GP, what can you tell me about the geology that will influence my patients locally?"
2. Further, GSI and GSNI should continue the successful outreach programme, using the above materials to help non-technical users understand how the data can help them
3. **RESI update** – the RESI document has provided the basis for the Tellus and Tellus Border projects. Fundamentally the strategy is sound. However the document is over 12 years old and does not reflect the insight/lessons learned from the successful delivery of the Tellus projects and other GSI/GSNI initiatives (including Infomar). We therefore recommend that GSI and GSNI see to update the strategy (working with other Government Agencies/Departments as appropriate), setting out a plan to extend geophysical and geochemical data collection in a prioritised manner to:
   - Include the rest of Ireland on a phased basis
   - Include additional data elements (e.g. inclusion of water borehole date)
   - Test the value of resurveying areas to provide time-series of particular data elements
   - Undertake further specific, targeted research. The research projects should be driven by feedback from the senior decision makers' outreach programme

   An updated strategy could be used for any future funding applications and would help stimulate further use of the existing datasets by providing assurance to stakeholders (in particular bodies with interest across Ireland) that there is a programme to get national coverage and that it is therefore worth investing in exploiting the data for the Tellus Border area in the interim.
4. **Research** – part of the value of the Tellus Border project has been the extensive research which has crossed borders. This could be further extended with the inclusion of the BGS projects, namely the Tellus South West and proposed Ireland-Wales projects. We see there merit in having a single coordinated approach to identifying, commissioning and driving out value from the data. Such an approach would be facilitated by the establishment of a social media forum (for example a Linkedin Group) to raise the profile of the data and help bring together potential research ideas. GSNI/GSI might also consider using the Geovation model (https://challenge.geovation.org.uk/), to help stimulate ideas and wider interest. Here applicants post ideas on a specific website for solutions to problems using the Tellus data and the best ideas go through a Dragon's Den-type process.[29] The intention is that the process is problem-driven, stimulates lots of ideas and relatively quick (rather than years)
5. **Data download** – In providing the current and future Tellus data, GSI should consider asking users for an e-mail address as part of the process for gaining access to data downloads (the web viewer would not require this). This could either be mandatory or optional, depending on GSI's/GSNI's appetite to identify users. Access to the data would still be free, however it would provide GSI/GSNI with a much better understanding as to who is downloading their data.

[29] E.g. Small Business Research Initiative http://www.detini.gov.uk/dt1_13_0160607___sbri__-_evidence_pack_-_final.pdf

APPENDICIES

APPENDIX A: CONSULTEES

Organisation	Name	Role
OCAE Consultants Ltd	David O'Connell	Geochemistry sampling contractor
Agri-Food and Biosciences Institute	Alex Higgins	Stakeholder - agriculture
Border Regional Authority	Padraig Maguire	Stakeholder - planning
British Geological Survey	David Beamish	Geophysics technical audit
British Geological Survey	Dr Andy Howard	Steering Committee member
British Geological Survey	Louise Ander	Geochemistry technical advisor
Council for Nature Conservation & Countryside	Peter Archdale	Stakeholder - environment
DCENR	Michael Manley	Funding body/Steering Committee
DECLG	John O'Neill	Funding body/Steering Committee
Department of the Environment	Theresa Kearney	Funding body/Steering Committee
DETI	Mike Thompson	Funding body/Steering Committee
Dundalk Institute of Technology	Dr Valerie McCarthy	Project partner
Exploration and Mining Division	Wayne Cox	Geochemistry TAG member
Geological Survey of Ireland	Dr James Hodgson	Tellus Border team (contractor)
Geological Survey of Ireland	Kate Knights	Tellus Border team (contractor)
Geological Survey of Ireland	Mairead Glennon	Tellus Border team (contractor)
Geological Survey of Ireland	Ray Scanlon	Tellus Border team (staff)
Geological Survey of Ireland	Shane Carey	Tellus Border team (contractor)
Geological Survey of Ireland	Koen Verbruggen	Director
Geological Survey of Northern Ireland	Dr Marie Cowan	Tellus Border team (staff)
Geological Survey of Northern Ireland	Mohammednur Dessisa	Tellus Border team (staff)
Geological Survey of Northern Ireland	Mike Young	Director
Louth County Council	Michael Curran	Stakeholder – local authority
Mineral exploration company	Aidan Lavelle	Stakeholder - mineral exploration
Mineral exploration company	Graham Reid	Stakeholder - mineral exploration
Mineral exploration company	Mark Holdstock	Stakeholder - mineral exploration
Monaghan County Council	Bernie O'Flaherty	Stakeholder – local authority
Morrow Communications	Claire Bonner	Public relations contractor
NI Cancer Registry	Dr Anna Gavin	Stakeholder – public health
NUI Galway	Eve Daly	Research contractor
Petroleum exploration company	Tony Bazley	Stakeholder - shale gas
Queen's University Belfast	Dr Alastair Ruffell	Project partner
Queen's University Belfast	Dr Jenny McKinley	Project partner

Radiological Protection Unit of Ireland	David Fenton	Stakeholder – public health
Special EU Programmes Body	Ciaran Hanna	Funding body
Special EU Programmes Body	Pat Colgan	Funding body
University College Dublin	John Walsh	Stakeholder - academic
University College Dublin	Pat Shannon	Stakeholder - academic
University of Birmingham	Carl Stevenson	Stakeholder – academic
University of Ulster	Paul Dunlop	Research contractor

APPENDIX B: DOCUMENTS REVIEWED

Assessment of Economic Contribution of Mineral Exploration and Mining in Ireland, Indecon International Economic Consultants (July 2013)

Cost benefit analysis of a resource & environmental survey of Ireland, Environmental Institute University College Dublin (2001)

Annual Survey of Mining Companies, Fraser Institute (2013)

Geo-environmental survey of the north of Ireland 'GESI North' - economic appraisal, BDO (June 2010)

Letter of offer, SEUPB (30th September 2010)

Post-Project evaluation of the Tellus Project, PA Consulting Group (August 2008)

Resource & Environmental Survey of Northern Ireland Economic Appraisal (PwC, March 2004)

Steering Committee meeting papers (1-13)

Weekly team meeting minutes

Quarterly reports to SEUPB

Tellus Border Airborne geophysical survey data processing report, GSNI/GSI (February 2013)

Tellus Border Airborne geophysical survey logistics report, GSNI/GSI (March 2013)

Tellus Border Google analytics report for 24 June 2011 to 18 March 2014

Tellus Border project Application Form, GSNI (July 2009)

Tellus Border Project Geochemistry Data User Guide, GSNI/GSI (March 2013)

Resource & Environmental Survey of Ireland/Northern Ireland, CSA, (2002/2003)

The Tellus Experience: A Mineral Exploration Perspective, Garth Earls, April 2012 at Geoscience 2012 conference in Dublin Castle

Tellus Border Communications Programme Report, GSI/GSNI, 2014

APPENDIX C PROJECT PUBLICATIONS

This appendix sets out the papers published based since April 2010 using the Tellus and/or Tellus Border data.

C.1 Published in journals

Ruffell, A. & McKinley, J. (2014) Forensic geomorphology. Geomorphology, vol 205, pp. 164-174.

McKinley, J, Ofterdinger, U, Young, M, Barsby, A & Gavin, A (2013) Investigating local relationships between trace elements in soils and cancer data;. Spatial Statistics, vol 5, pp. 25-41., http://dx.doi.org/10.1016/j.spasta.2013.05.001

Keaney, A, McKinley, J, Graham, C, Robinson, M & Ruffell, A (2013) Spatial statistics to estimate peat thickness using airborne radiometric data. Spatial Statistics, vol 5, pp. 3-24., http://dx.doi.org/10.1016

Palmer, S, Ofterdinger, U, McKinley, J, Cox, S & Barsby, A (2013) Spatial Analysis Approaches to Investigate the Bioaccessibility of Nickel, Vanadium and Zinc in Northern Ireland, UK Soils Environmental Geochemistry and Health, vol 35, no. 5, pp. 569-584., http://dx.doi.org/10.1007/s10653-013-9540-0

Cox, S, Chelliah, M, McKinley, J, Palmer, S, Ofterdinger, U, Young, M, Cave, MR & Wragg, J (2013) The importance of solid-phase distribution on the oral bioaccessibility of Ni and Cr in soils overlying Palaeogene basalt lavas, Northern Ireland. Environmental Geochemistry and Health, vol 35, no. 5, pp. 553-567., http://dx.doi.org/10.1007/s10653-013-9539-6

Barsby, A, McKinley, JM, Ofterdinger, U, Young, M, Cave, MR & Wragg, J (2012), Bioaccessibility of trace elements in soils in Northern Ireland. Science of The Total Environment, vol 433, no. null, pp. 398-417., http://dx.doi.org/10.1016/j.scitotenv.2012.05.099

Rawlins, B.G. Scheib, C. Beamish, D. Webster, R. Tyler, A.N. Young, M.E. (2011) Landscape-scale controls on the spatial distribution of caesium 137: a study based on an airborne geophysical survey across Northern Ireland. Earth Surface Processes and Landforms, 36 (2). 158-169. 10.1002/esp.2026

Beamish, D.(2013) Gamma ray attenuation in the soils of Northern Ireland, with special reference to peat. Journal of Environmental Radioactivity, 115,13-27

Beamish, David (2014) Peat mapping associations of airborne radiometric survey data. Remote Sensing, 6 (1), 521-539. 10.3390/rs6010521

Beamish, David. (2013) Gamma ray attenuation in the soils of Northern Ireland, with special reference to peat. Journal of Environmental Radioactivity, 115, 13-27. 10.1016/j.jenvrad.2012.05.031

Beamish, David. (2013) The bedrock electrical conductivity structure of Northern Ireland. Geophysical Journal International, 194 (2), 683-699. 10.1093/gji/ggt073

Beamish, D. Kimbell, G.S. Stone, P. Anderson, T.B. (2010) Regional conductivity data used to reassess Early Palaeozoic structure in the Northern Ireland sector of the Southern Uplands-Down-Longford terrane. Journal of the Geological Society, 167 (4), 649-657. 10.1144/0016-76492009-122

Scheib, Cathy; Beamish, David. (2010) High spatial resolution observations of 137Cs in northern Britain and Ireland from airborne geophysical survey. Journal of Environmental Radioactivity, 101 (9), 670-680. 10.1016/j.jenvrad.2010.03.010

Rawlins, B.G. Scheib, C. Tyler, A.N. Beamish, D. (2012) Optimal mapping of terrestrial gamma dose rates using geological parent material and aerogeophysical survey data. Journal of Environmental Monitoring, 14 (12), 3086-3093. 10.1039/C2EM30563A

Macintosh, K.A and Griffiths, D. December (2013) Catchment and in-stream influences on metal concentration and deposit density in upland steams. Environmental Earth Sciences, 70, (7), pp 3023-3030

Lusty, P.A.J. Scheib, C. Gunn, A.G. Walker, A.S.D. (2012) Reconnaissance-scale prospectivity analysis for gold mineralisation in the Southern Uplands-Down-Longford Terrane, Northern Ireland. Natural Resources Research, 21 (3), 359-382. 10.1007/s11053-012-9183-3

Appleton, J.D. Miles, J.C.H. Young, M. (2011) Comparison of Northern Ireland radon maps based on indoor radon measurements and geology with maps derived by predictive modelling of airborne radiometric and ground permeability data. Science of the Total Environment, 409 (8), 1572-1583. 10.1016/j.scitotenv.2011.01.023

Appleton, J.D. Doyle, E. Fenton, D. Organo, C. (2011) Radon potential mapping of the Tralee-Castleisland and Cavan areas (Ireland) based on airborne gamma-ray spectrometry and geology. Journal of Radiological Protection, 31 (2), 221-235. 10.1088/0952-4746/31/2/002

Lark, R.M., Ander, E.L., Cave, M.R., Knights, K.V., Glennon, M.M. and Scanlon, R.P. (2014) Mapping trace element deficiency by cokriging from regional geochemical soil data: a case study on cobalt for grazing sheep in Ireland. Geoderma, 226–227, 64–78.

Hollis, S. P., Cooper, M.R., Roberts, S., Earls G., Herrington, R & Condon, D. J. (2013) New stratigraphic, geochemical and U-Pb zircon constraints from Slieve Gallion, Northern Ireland: A correlation of the Irish Caledonide arcs. Journal of the Geological Society, London.

Hollis, S. P., Cooper, M.R., Roberts, S., Earls G., Herrington, R & Condon, D. J. (2013) Late obduction of the Northern Irish, Tyrone ophiolite during the Grampian-Taconic orogeny: A correlative to the Annieopsquotch Ophiolite Belt of central Newfoundland? Journal of the Geological Society, London.

Cooper, M. R., Crowley, D. J., Hollis, S. P., Noble, S. R, & Henney, P. (2013) A U-Pb age for the Late Caledonian Sperrin Mountains minor intrusions suite in the north of Ireland: timing of slab break-off in the Grampian terrane and the significance of deep-seated, crustal lineaments. Journal of the Geological Society, London.

Dempster, M., Dunlop, P. Scheib, A. & Cooper, M. (2013). Principal Component Analysis of Geochemistry of Soils Developed on Till in Northern Ireland. Journal of Maps. doi:1O.1080/17445647.2013.789414

Hollis, S. P., Roberts, S., Cooper, M.R, Condon, D. J., Earls G., Herrington, Matthew, R, Cooper, 1., Archibald, S. M. & Piercey, S. J. (2012) Episodic arc-ophiolite emplacement and the growth of continental margins: Late accretion in the Northern Irish sector of the Grampian-Taconic orogeny. Geological Society of America Bulletin.

Cooper, M. R, Anderson, H., Walsh, J. J., Van Dam, C. L., Young, M. E., Earls, G. & Walker, A. (2012) Palaeogene Alpine tectonics and Icelandic plume-related magmatism and deformation in Ireland. Journal of the Geological Society, London, 169; p. 29-36. doi: 10.1144/0016-76492010-182

C.2 Workshops/fieldtrips

2013, 4-day Tellus Border geology field trip for GSI/GSNI, 22-25 May 2013

2012, 2013, Jenny McKinley: 2 day workshop in UCD on Using GIS in Earth Sciences featuring GSNI and Tellus digital data

2012, Ray Scanlon: 1 day workshop in UCC on using Tellus and Tellus Border data on MSc course

2012, Garth Earls: MSc module at UCC using Tellus data

2011 and 2012, Jenny McKinley, QUB GAP Masters in Heritage Science – Tellus data as part of GIS practical's, coursework and seminar.

2012, James Hodgson; Fieldtrip for the Irish Association of Economic Geology

2012, Shane Carey, spatial data workshop with DIT MSc Spatial Information Management students

C.3 Published Conference Abstracts

Hodgson. J., Knights. K., Glennon. M., Carey. S and Ture, M.D. (2013) Airborne radiometric data assessment and comparison with topsoil geochemical U, Th and K in the border region of the Republic of Ireland. Near Surface Geophysics Conference, Bochum.

James Hodgson, Kate Knights, Mairéad Glennon, Shane Carey and Mohammednur Desissa., EAGE Airborne radiometric data assessment and comparison with topsoil geochemical U, Th and K in the border region of the Republic of Ireland.

J. Hodgson and M. Desissa Ture: Preliminary interpretations of the Ireland airborne geophysical Surveys: constrained from the Tellus and Tellus Border Data sets.

Hodgson, J. and Carey, S. (2014) Using Tellus airborne geophysical and geological data to map radon risk potential. Environ 2014.

Hodgson, J. & Ture, M.D. (2013) Tellus Border: Examples from a regional survey British Geophysical Association Aeromagnetic Interpretation Meeting, London, 31st July 2013.

Young, M.E., Cowan, M.T., Scanlon, R.P. and Glennon, M.M. (2013) Stimulating Exploration by Government-Sponsored Regional Geo-Science Surveys . Exploration, Resource and Mining Geology Conference 2013, 21-22 October 2013, Cardiff.

Glennon, M., Knights, K., Scanlon, R and Young, M.E. (2011) Tellus Border project: Catchment scale characterisation of soil and water for environmental management. Catchment Science 2011, 14-16 September 2011, Dublin, Ireland.

Knights, K.V., Scanlon, R. P., and Glennon, M. (2012). Tellus Border: Regional geochemical surveys of the northern region of Ireland. 9th International Symposium on Environmental Geochemistry, 15-21 July 2012, Aveiro, Portugal.

Carey, S., Glennon, M.M. and Scanlon, R.P. (2013) Utilizing open-source programming languages to statistically and spatially analye regional-scale geoenvironmental datasets. AGILE 2013, Leuven, May 14-17, 2013.

Knights, K.V., Glennon, M.M. and Scanlon, R.P. (2013) New regional geochemical data from Ireland: investigating trace element distributions in topsoil and potential agricultural impacts. 29th International Conference of the Society for Environmental Geochemistry and Health, 8-12th July 2013, Toulouse, France.

Lark, R.M., Ander, E.L., Cave, M.R., Knights, K.V., Glennon, M.M., and Scanlon, R.P. (2014) Predicted risk of cobalt deficiency in grazing sheep from a geochemical survey; communicating uncertainty with the IPCC verbal scale. Geophysical Research Abstracts, 16, European Geosciences Union General Assembly 2014.

Knights, K.V. and Scanlon, R.P. (2013) Tellus: Regional-scale baseline geochemical mapping of soil, stream sediment and stream water for the island of Ireland. Goldschmidt2013, Florence, 25-30 August 2013. Mineralogical Magazine, 77(5), 1482.

5th Irish Earth Observation Symposium, Cork, 17-18 November 2011.

Hodgson, J and Sheehy, M. (2013) Tellus Border: Regional geological and environmental mapping through airborne geophysics Irish Earth Observation Symposium,.

Tellus Border session at the Irish Geological Research Meeting, University of Cork, 18-19 February 2012:

- R.P. Scanlon, M. T. Cowan, M. Glennon, K. V. Knights, M. Desissa, V. Gallagher, J. Hodgson, S. Carey and C. McGinn. Tellus Border project – project update and research opportunities
- P. Anderson, J. Inman, D. Condon, Q. Crowley, Colm Hurley, I. Meighan, R. Ellam, J. Reavy, C. Stevenson and M. Cooper. The structure and emplacement of the Newry Igneous complex from Tellus geophysical data and AMS
- M. Dempster, P. Dunlop, A. Scheib and M. Cooper. Unravelling glacial sediment provenance in Northern Ireland using soil geochemistry
- A. Keaney, J. McKinley and A. Ruffell. Soil carbon and peat depth assessment using airborne geophysical data
- R. Amer, U. Ofterdinger, A. Ruffell and A. Donald. Remote sensing and GIS for landuse/landcover classification and water quality in the Northern Ireland
- M. Robinson, J. McKinley, A. Ruffell and M.Young. Investigating the use of Tellus data to improve peat depth models for Northern Ireland

Tellus Border session at the Irish Geological Research Meeting, University of Ulster, 1-3 March 2013.

- Keaney,A., McKinley, J., Ruffell, A., Robinson, M. Graham, C, Hodgson, J and Desissa, M. Soil carbon and peat depth assessment – ground-truthing airborne geophysical data.
- Hodgson, J., Desissa, M., Scanlon, R., Knights, K., Carey, S and Glennon, M., Tellus Border: New airborne geophysics and geochemistry data and preliminary interpretations.
- McIlwaine, R., Cox., S and Doherty, R. Investigating the difference between anthropogenic and geogenic contamination – identifying domains and calculating Normal Background Concentrations in Northern Ireland.
- Palmer, S. Ofterdinger, U. and McKinley, J. Spatial geochemical factors influencing the oral bioaccessibility of potentially toxic elements in Northern Irish soils.

Tellus Border presentations at the Irish Geological Research Meeting, University College Dublin, 28 Feb – 2 Mar 2014:

- Scanlon, R., Glennon, M., Cowan, M. Desissa, M., Hodgson, J., Knights, K., Carey, S. Tellus Border: geophysical and geochemical datasets shed new light on the geology of Ireland.
- McKinely, J. and Ruffell, A. Tellus Border soil carbon ebook: an interactive presentation.
- O'Connell, Y and Daly, E. Groundwater and land resources in Tellus Border coastal zones.

Keaney, A., McKinley, J., Robinson, M., Graham, C., Hodgson, J. and Desissa, M. (2012) Ground-truthing Airborne Geophysical Data for carbon stock modelling. EAGE Remote Sensing Workshop, 3-5-Sep-12, Paris. 18th European Meeting of Environmental and Engineering Geophysics.

Hodgson, J., Desissa, M., Scanlon, R., Glennon, M., Knights, K. and Carey, S. (2012) Tellus Border Regional geo-environmental mapping through airborne geophysics and geochemistry sampling. Irish Earth Observation Symposium, 1-2 Nov 2012.

Robinson, M., Ofterdinger, U. Ruffell, A., Wilson, C., Cassidy, R., Comte, J.C. Cowan, M., Beamigh, D and Desissa, M. Monitoring groundwater contaminant plumes using airborne geophysical data. European Geosciences Union general assembly, Vienna, 7-12 April 2013

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Keaney, A. (2012) Soil carbon postdoc presentation. International Peat Society conference, 15-17-Oct-12

Rolston, A. (2012) Wetlands postdoc presentation. ENVIRON Conference, UCD on 8th March 2012.

McCarthy, V. (2013) Wetlands postdoc presentation. International Limnology conference.

C.4 Senior level presentations

- North South Ministerial Council - Environment
- North South Ministerial Council - Finance
- EU Parliamentary Committee for Regional Development
- House of Commons All Party Committee on the environment and earth sciences

APPENDIX C: REPORT ACRONYMS

BGS	British Geological Survey
DCENR	Department of Communications, Energy and Natural Resources
DECLG	Department of Environment, Community and Local Government
DETI	Department for Enterprise, Trade and Investment (Northern Ireland)
DkIT	Dundalk Institute of Technology
DoE	Department of Environment (Northern Ireland)
EPA	Environmental Protection Agency
GIS	Geographic Information Systems
GSI	Geological Survey of Ireland
GSNI	Geological Survey of Northern Ireland
NERC	Natural Environment Research Council
NI	Northern Ireland
NIEA	Northern Ireland Environment Agency
PA	PA Consulting Group
PSI	Public Sector Information
QUB	Queens University Belfast
RESI	Resource and Environmental Survey of Ireland
RPII	Radiological Protection Institute of Ireland
ROI	Republic of Ireland
SGL	Sander Geophysics Ltd
SEUPB	Special EU Programmes Body

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Corporate headquarters
123 Buckingham Palace Road
London SW1W 9SR
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Tel: +44 20 7730 9000

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