

**Summary comparison of key similarities and differences between the geochemical survey programmes of Tellus (NI) and Tellus Border (ROI, 2011-2013).**

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High resolution and systematic geochemical baseline mapping of the surface environment was carried out in Northern Ireland, (1994 to 2006) and in the Republic of Ireland counties of Donegal, Sligo, Leitrim, Cavan, Monaghan and Louth (2011 to 2013). The key similarities and differences of the geochemical survey programmes are summarised below:

<b>Survey design and sample collection</b>	<b><u>Northern Ireland</u></b>	<b><u>Republic of Ireland</u></b>
Project name	Tellus	Tellus Border
Led by (partners)	DETI NI / GSNI / BGS	GSI / GSNI
Main years of surveys	1994–96; 2004–2006	2011–2012
Coverage counties	Antrim, Armagh, Down, Fermanagh, Londonderry and Tyrone	Donegal, Sligo, Leitrim, Cavan, Monaghan and Louth
Regional / urban	Urban soil survey of urban centres of Belfast Metropolitan Area and Londonderry urban areas. (Average sampling density 4 per 1 km <sup>2</sup> .)	No routine urban surveying <sup>1</sup> .
Sample media general	Topsoil, subsoil, stream sediment, stream water, heavy mineral panned concentrate, selected rock lithochemical sampling.	Topsoil, subsoil, stream sediment, stream water, heavy mineral panned concentrate, twiggy vegetation sample.
Topsoil (type 'A'). Edelman hand collection as per G-BASE protocols.	Nominally 5–20 cm depth. Average sampling density 1 per 2 km <sup>2</sup> .	Nominally 5–20 cm depth. Average sampling density 1 per 4 km <sup>2</sup>
Subsoil (type 'S'). Edelman hand auger collection as per G-BASE protocols.	Nominally 35–50 cm depth (variable). Average sampling density 1 per 2 km <sup>2</sup> .	Nominally 35–50 cm depth (variable). Average sampling density 1 per 4 km <sup>2</sup> .
Stream sediment (type 'C') <150 µm wet sieved at site as per G-BASE protocols with sieve set and nylon sieve mesh.	Average sampling density 1 per 2 km <sup>2</sup> . Use of G-BASE wooden sieve sets.	Average sampling density 1 per 4 km <sup>2</sup> (although highly variable across survey area due to drainage network density). Use of plastic formed sieve sets.
Stream water filtered, acidified for multi-element analyses (type 'F/A'). 60 ml collected.	Average sampling density 1 per 2 km <sup>2</sup> .	Average sampling density 1 per 4 km <sup>2</sup> (although highly variable across survey area due to drainage network density).
Stream water filtered, not acidified for anions analyses (type 'F/UA'). 30 ml collected.	Average sampling density 1 per 2 km <sup>2</sup> .	Average sampling density 1 per 4 km <sup>2</sup> (although highly variable across survey area due to drainage network density).
Stream water, unfiltered sample for pH, electrical conductivity, total alkalinity determinations.	Average sampling density 1 per 2 km <sup>2</sup> . Determined at field base same or next day.	Average sampling density 1 per 4 km <sup>2</sup> (although highly variable across survey area due to drainage network density). Determined at site / at field base same or next day.
Heavy mineral panned concentrate of stream sediment (type 'P')	Average sampling density 1 per 2 km <sup>2</sup> .	Average sampling density 1 per 4 km <sup>2</sup> (although highly variable

>150 µm and <2 mm wet sieved at site as per G-BASE protocols	Use of dulang style wooden panning dishes.	across survey area due to drainage network density). Use of plastic Estwing style panning dishes.
Vegetation (type 'V') twiggy material collected as per G-BASE protocols	<i>Samples not collected</i>	Average sampling density 1 per 4 km <sup>2</sup> (although highly variable across survey area due to drainage network density).
Project code(s) – first two digits used for sample numbers	55, 56, 57	58
Personnel in field programme	Students / voluntary workers led by BGS baseline geochemistry staff.	OCAE Consultants Ltd employing field personnel and team leaders.
Number of soil sites	c. 7000	c. 3500
Number of drainage sites	c. 6000	c. 3500

<b>Sample preparation and analytical geochemistry</b>	<b><u>Northern Ireland</u></b>	<b><u>Republic of Ireland</u></b>
Project name	Tellus	Tellus Border
Led by (partners)	DETI NI / GSNI / BGS	GSI / GSNI
Main years of prep./analytical work	1993–95; 2004–2006	2012–2013
Coverage counties	Antrim, Armagh, Down, Fermanagh, Londonderry and Tyrone	Donegal, Sligo, Leitrim, Cavan, Monaghan and Louth
Commercialised work?	Yes	Yes
Sample preparation of stream sediments (type 'C')	BGS Sample Preparation Facility	BGS Sample Preparation Facility
Sample preparation of topsoil (type 'A')	BGS Sample Preparation Facility	BGS Sample Preparation Facility
Sample preparation of subsoil (type 'S')	BGS Sample Preparation Facility	<i>Samples not yet prepared</i>
Solid sample multi-element analyses by XRFs	Stream sediments (type 'C') Topsoils (type 'A')	Stream sediments (type 'C')
Solid sample multi-element analyses by ICP(-MS) (following digest)	Topsoils (type 'A') - <i>aqua regia</i> variant sample digestion. Subsoils (type 'S') - <i>aqua regia</i> variant sample digestion. Subsoils (type 'S') – “near total” four-acid strong sample digestion.	Topsoils (type 'A') – <i>aqua regia</i> variant sample digestion.
Solid sample pH determination	Topsoils (type 'A')	Topsoils (type 'A')
Solid sample loss-on-ignition (LOI) determination	Topsoils (type 'A')	Topsoils (type 'A')
Solid sample fire assay analyses for Au, Pt, Pd.	Stream sediments (type 'C') Subsoils (type 'S')	Stream sediments (type 'C') <i>not yet complete – expected Summer 2013</i>
Stream water multi-element analyses by ICP (-AES, -MS)	Stream waters (type 'F/A'). Acidified to 1% v/v with conc. HNO <sub>3</sub> .	Stream waters (type 'F/A'). Acidified to 1% v/v with conc. HNO <sub>3</sub> . Whole sample additionally acidified by analytical laboratory with 0.5% v/v HCl.
Stream water anions analyses by IC and NPOC	Stream waters (type 'F/UA')	Stream waters (type 'F/UA')



Notes	Significant differences in aqueous analyses wrt detection limits and determinands between surveys of 1994-96 and 2004-06.	
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Analytical summary by method	Solid samples <i>i.e.</i> soil, stream sediment					
Analytical method	XRFS	ICP (-MS, -OES) following chemical extraction of solid sample		pH of soil sample	Loss-on-ignition (LOI) of solid sample	Fire assay for Au, Pt, Pd.
What is measured	Total concentrations of major, minor and trace elements.	Concentrations of major, minor and trace elements, extracted by specific reagents into a solution which is analysed.		pH (acidity) of soil slurry.	Combustible matter, a proxy for organic matter in sample.	Concentrations of precious group elements (PGE).
Typical number of determinands	c. 55	c. 50–60		1	1	3–4
Special preparation?	Pressed powder pellets of 12 g sample.	No. Milled sample is extracted by reagents, solution is analysed.		Sample is mixed (2.5:1) with CaCl <sub>2</sub> solution to form a slurry, then measured with a probe.	No. Milled sample is combusted.	Milled sample fired with lead oxide flux mixture.
Mode of chemical extraction	N/A	Strong two-acid mixture <i>Aqua regia</i> acid ratio 2:1 HNO <sub>3</sub> :HCl	Strong four-acid mixture, sometimes referred to as “near-total” acid ratio 2-1-2-2 HF-HClO <sub>4</sub> -HCl-HNO <sub>3</sub>	Mixture with 0.01 M CaCl <sub>2</sub> solution	N/A	N/A
Destructive technique?	No	Yes (mass depends on method, 1 g used here)		Yes (5–10 g)	Yes (1–2 g)	Yes (10–15 g)
Projects/areas/samples:	Solid samples <i>i.e.</i> soil, stream sediment					
<b>Western NI (DETI NI/GSNI/BGS)</b>	Stream sediments (type ‘C’)					Stream sediments (type ‘C’)
<b>Tellus Eastern NI (GSNI/BGS)</b>	Stream sediments (type ‘C’)					Stream sediments (type ‘C’)
<b>Tellus all NI (GSNI/BGS)</b>	Stream sediments (type ‘C’) Topsoils (type ‘A’)	Topsoils (type ‘A’)	Subsoils (type ‘S’)	Topsoils (type ‘A’)	Topsoils (type ‘A’)	Subsoils (type ‘S’)
<b>Tellus Border</b>	Stream sediments (type ‘C’)	Topsoils (type ‘A’)		Topsoils (type ‘A’)	Topsoils (type ‘A’)	Stream sediments (type ‘C’) <i>not yet complete</i>



<b>Analytical summary by method</b>	<b>Aqueous samples <i>i.e.</i> stream waters</b>		
Analytical method	ICP (-MS, -OES, -AES) of aqueous solution	Ion chromatography (IC) of aqueous solution	Non-purgeable organic carbon (NPOC) of aqueous solution
What is measured	Concentrations of major, minor and trace elements that are dissolved in solution.	Concentrations of major anions that are dissolved in solution.	Concentration of organic carbon that is dissolved in solution.
Typical number of determinands	c. 50–60	c. 7–10	1
Special preparation?	Filtered water. Sample needs to be acidified, to stabilise the sample and keep elements dissolved in solution.	Filtered water.	Filtered water.
Mode of chemical extraction	N/A	N/A	N/A
Destructive technique?	Hardly (volume depends on method)	(Hardly)	(Hardly, 6 mL)
<b>Projects/areas/samples:</b>	<b>Aqueous samples <i>i.e.</i> stream waters</b>		
<b>Western NI (DETI/GSNI/BGS)</b>	Stream waters (type 'F/A')	Stream waters (type 'F/UA')	Total organic carbon on stream waters (type 'F/UA')
<b>Tellus Eastern NI (GSNI/BGS)</b>	Stream waters (type 'F/A')	Stream waters (type 'F/UA')	Stream waters (type 'F/UA')
<b>Tellus all NI (GSNI/BGS)</b>			
<b>Tellus Border</b>	Stream waters (type 'F/A')	Stream waters (type 'F/UA')	Stream waters (type 'F/UA')



**Additional Tellus (NI) analyses not summarised above:**

- Sulphate determined on 1 g of subsoil samples (type 'S') by dilute hydrochloric leach followed by ICP-AES analyses.
- Boron determined on 0.1 g of stream sediment samples (type 'C').

**Key things to note:**

- Tellus (NI) topsoil samples were analysed by both XRFs and ICP following a two-acid *aqua regia* type chemical extraction (digestion using 2:1 HNO<sub>3</sub>:HCl). This is a unique dataset allowing for the comparison of the different analytical methods.
- Tellus (NI) topsoil and subsoil samples were analysed by **different analytical methods**, which are not *directly* comparable. However, it is unique to Tellus to have a full regional geochemical dataset for both topsoils and subsoils.

**Integration of cross-border datasets:**

- Integrated datasets for NI and RoI can be achieved where the same sampling and analytical methodology has been applied. This is the case for stream sediments (analysed by XRFs); topsoils (analysed by ICP following a two-acid *aqua regia* type chemical extraction); and stream waters **only**.
- Direct comparisons of NI and RoI analytical data with GB data can be made for stream sediments (analysed by XRFs) and stream waters.
- Direct comparisons of NI analytical data with GB data can be made for stream sediments and topsoils (analysed by XRFs) and stream waters.
- An integrated Au, Pt, Pd fire assay dataset for NI and RoI can only be achieved for the stream sediments, due to the fact that Tellus Border is not preparing its subsoil (type 'S') samples.

**Other notable geochemical surveys of the island of Ireland:**

- FOREGS multi-media European geochemical survey carried out in NI and RoI (conducted 1998 in Ireland). [www.gtk.fi/publ/foregsatlas/](http://www.gtk.fi/publ/foregsatlas/)
- GEMAS survey of agricultural soils carried out in NI and RoI (conducted 2008). Samples analysed by XRFs and by ICP following *aqua regia* digestion. <http://www.ngu.no/en-gb/hm/Publications/Reports/2008/2008-038/>
- Teagasc soil geochemical atlas of Ireland (conducted 1995–2005). Samples analysed by ICP following four-acid mixture “near-total” digestion. [http://www.teagasc.ie/publications/2011/822/Soil\\_Geochemical\\_Atlasofireland.pdf](http://www.teagasc.ie/publications/2011/822/Soil_Geochemical_Atlasofireland.pdf)

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<sup>1</sup> Urban geochemical survey of Dublin carried out under Dublin SURGE Project, conducted 2010–2011 by GSI in collaboration with NGU <http://www.gsi.ie/Surge.htm>