Musings on Doctoral Level Geospatial Education: Lessons from the EPSRC CDT in Geospatial Systems

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Keywords: Cohort, Curricula Development, Doctorate, Education, Pedagogy, PhD.

Abstract

The EPSRC Centre for Doctoral Training (CDT) in Geospatial Systems was established in 2019 with a vision to establish an internationally recognised centre of excellence and an ambition to graduate 50 doctoral students across five annual cohort intakes. Since that time, the CDT has been delivered through a strategic partnership between Newcastle University and the University of Nottingham in the UK, together with c. 40 external partners from global academia, international industry and UK Government. The first doctoral students graduated from the CDT in July 2024, with the final students expected to complete their PhD studies in 2028. This paper provides an overview of the training structure and skills development initiatives implemented and offers critical reflections on the experiences and challenges encountered throughout the CDT's lifetime to date (February 2026). While the content will be of particular interest to academics and stakeholders involved in any branch of geospatial doctoral training, many of the findings are transferable. As such, the insights presented may also be of value to the wider academic community, particularly those considering the establishment of similar cohort-based doctoral training models.

1. Introduction

UK Research and Innovation (UKRI) is a non-departmental public body sponsored by the UK Government's Department for Science, Innovation and Technology (DSIT). UKRI brings together the seven disciplinary research councils responsible for supporting research and knowledge exchange at higher education institutions in England, including the Engineering and Physical Sciences Research Council (EPSRC). It provides funding to UK universities for doctoral research through various routes, one particular mechanism being via calls for Centres for Doctoral Training (CDTs) in strategic areas of national priority. CDTs can be defined as, *"collaborations between universities and industry partners that provide structured PhD training. Funded by UKRI, CDTs offer fully-funded four-year studentships. In some cases, they may even offer an integrated Master's in the first year (also known as a 1+3 programme)"* (Medha, 2025).

The economic significance of location-based data was formally acknowledged by the UK Government in November 2017, with the launch of its Geospatial Commission (Gov-UK, 2017). Whilst the Commission ultimately became subsumed into the Government Digital Service in January 2025, the Commission aimed to unlock an estimated £11B in annual economic value through improved accessibility and utilisation of geospatial data. Independent to this UK Government initiative, UKRI ran a coincident funding call for new CDTs in 2018. A bid led by Newcastle University argued that for the UK to realise the full economic and societal potential of geospatial data envisaged by government, a national cohort of highly trained, interdisciplinary geospatial practitioners was required. A CDT in Geospatial Systems was successfully proposed to fulfil this objective, providing a unique opportunity for academic institutions to collaborate with the geospatial industry and broader applied user communities.

UKRI announced the establishment of the EPSRC CDT in Geospatial Systems in early 2019. This was one of 75 centres funded under the 2018 call, representing a total investment of over £500M in doctoral training by UKRI. The CDT in Geospatial Systems was one of only four centres funded within the thematic area of "Towards a Data-Driven Future,", and the only one to focus explicitly on geospatial data, analytics, and modelling (see UKRI, 2026).

Since 2019, the CDT has been delivered through a strategic partnership between Newcastle University (as the lead institution) and the University of Nottingham (as equal partner). The EPSRC contributed £7.029M to the initiative, which has been further supported by an estimated £4.3M in direct and in-kind contributions from c. 40 industry partners. The CDT's ambition was to train and graduate 50 PhD students across five annual cohorts, recruited between 2019 and 2023, and the first doctoral students graduated from the CDT in July 2024. This paper provides an overview of the EPSRC CDT in Geospatial Systems. It offers reflections on the experiences, outcomes, and challenges encountered, from CDT inception to the present day (February 2026). While the content will be of particular interest to geospatial academics, many of the findings are transferable and will be of value to the wider community, particularly those considering similar cohort-based training models.

2. The EPSRC CDT in Geospatial Systems

2.1 CDT Aims and Objectives

The aim of the EPSRC CDT in Geospatial Systems was to establish an internationally recognised centre of excellence of doctoral training, delivering the future leaders and transformative research capability to enable the UK to maximise the economic benefits of geospatial data. Its' key objectives were to:

1. develop a national cohort of doctoral researchers that collectively form the highly skilled professionals required to realise the strategic opportunity arising from the ‘open’ geospatial data revolution;

2. co-develop with industry and the applied user base a research training environment and set of PhDs to provide UK industry with the geospatial engineers equipped with the computational and mathematical skills required to maximize the big data, cloud computing, Artificial Intelligence (AI) and Internet of Things (IoT) technologies driving economic growth;

3. deliver bespoke industry informed cohort wide training on Innovation, Enterprise, Leadership (IEL) and engagement, including Responsible Research and Innovation (RRI), to develop the skills required to translate research into operational innovative business solutions;

4. provide a cohort focused centre where both vertical and horizontal cohort peer-to-peer engagement and co-working was the norm within a tightly knit research community;

5. maximise impact by engaging with other CDTs and national bodies, such as the Geospatial Commission and National Innovation Centre for Data, to transfer training and research excellence across academia and industry;

6. become a “beacon” of Equality, Diversity and Inclusion (EDI) which recognises that life-experiences of people from different backgrounds, cultures and countries adds diverse and relevant skills, beyond traditional academic qualifications;

7. develop a global community via international collaboration, PhD research visits and secondments, to address economic, societal and environmental interdisciplinary research problems.

2.2 Technical Themes and Applied Domains

2.2.1 CDT Technical Training Themes: The CDT was developed around five technical themes selected on the basis of: (i) the predicted future developments that would shape the global geospatial industry and its wider economic impact in fields such as transport, infrastructure, and location-based services; (ii) consultation with c. 40 companies, consultancies and professional bodies regarding the key skills geospatial engineers, scientists and practitioners require; (iii) a review of the emerging international trends in global geospatial systems training. The resulting themes, that collectively form an end-to-end geospatial pipeline, were:

1. Spatial data capture and interpretation – modern geospatial data capture and monitoring approaches, including GNSS, EO, UAVs, and spatial sensor networks.

2. Spatial statistics and mathematical methods – analysis and modelling of extreme spatial events; robust statistical data assimilation methods; network resilience analysis; second-order spatiotemporal effects and impacts on networks.

3. Big data spatial analytics – computational skills required for modern geospatial data analysis and modelling, including cloud, big data management frameworks, edge and IoT computing.

4. Spatial analysis and modelling – approaches to large scale geodemographic analysis, coupled multi-scale urban-infrastructure models, advanced agent-based models, multi-objective spatial optimisation, evolutionary computing and AI.

5. Visualisation and decision support – recognising the importance in facilitating stakeholder engagement with complex geospatial data outputs, the use of high-performance computing and big data frameworks to visualise Building Information Models (BIM), real-time visualisation of network simulations, database interfaced spatial decision support tools and the visualisation of environmental data feeds.

2.2.2 CDT Application Domains: The CDT recognises eight applied domains, chosen as: (i) areas of expertise within the host institutions that directly address UK Government national priorities; (ii) delivering the interdisciplinary research required for improved decision making and planning with regards to major global societal issues, such as climate change impacts. The chosen domains were: *smart cities; urban and infrastructure resilience; spatially informed mobility; spatially engineered energy systems; long-term sustainable spatial planning; multi-scale structural monitoring; social inclusion and healthy living; global challenges.*

2.3 1+3 Training Model

A 1+3 model of training delivery was adopted, where students read for a MRes in Geospatial Data Science for one year, prior to commencing a 3-year PhD in Geospatial Systems in Year 2.

2.3.1 Year 1: MRes in Geospatial Data Science: Parallel MRes programmes in Geospatial Data Science were developed at both Newcastle and Nottingham. A MRes consists of 180 credits (90 ECTS), with a considerable research element (n.b. 10 credits equate to 100 hours of study). Programme development reflected the five technical training themes described in Section 2.2.1, primarily drawing on existing module content at the two universities, with bespoke elements jointly delivered to both Newcastle and Nottingham students. Table 1 shows the sequence of MRes content delivery.

Training Theme	Newcastle modules	Nottingham modules
Spatial data capture and interpretation	Geospatial sensors, platforms and data (Trimester 1:10 credits; Nottingham)	
Spatial statistics and mathematical methods	Statistical foundations of data science (T1:10)	Fundamentals of statistics (T1:10)
Big data spatial analytics	Programming for big data (T1:10) Big data analytics (T2:10)	Data at scale: management, processing and visualisation (T2: 20)
Spatial analysis and modelling	Geospatial informatics & modelling (T1:10) Machine learning (T1:10)	Spatial decision making (T1:10) Machine learning & predictive analytics (T1:10)
Visualisation and decision support	Data visualisation (T1:10)	Mapping for engineering surveying and GIS (T1: 10)
RRI	Understanding geo data: social, legal & ethical perspectives (T2:10; NCL)	
Group project	5-day CDT-wide residential workshops + work at home institution (T2:20)	
Research project	Individual research project (T2/3:80)	

Table 1. CDT MRes technical training themes, related modules, trimester taught and modular credits.

All students began the programme with induction and a common 10 credit block module on sensors and platforms jointly delivered by Newcastle and Nottingham academics, with industry guest speakers, at the University of Nottingham (Figure 1). They then followed a taught schedule on the remaining technical themes throughout Trimester One at their home institution. In Trimester Two, students evolved more to research content, with bespoke modular training in RRI followed by a joint 20 credit group project before embarking on an 80-credit individual research project, undertaken primarily in Trimester Three. The individual project is treated as a taster of the student’s chosen research topic ahead of commencing the PhD.

Figure 1. Cohort 5 students meet for the first time at the opening MRes module in Nottingham, September 2023.

To deliver the cohort impact of the CDT to the UK economy, a mentality of leadership and innovation was also ingrained within modules, starting with the first induction week where industry speakers provided a broad introduction on what makes a good research focused leader. Understanding the ethical, legal and social impact of the different types of geospatial data now routinely collected is critically important: with spatial data and analytics raising concerns over locational privacy and confidentiality, as well as legal and regulatory concerns, the geospatial field faces significant RRI challenges. To ensure a geospatially focused consideration of these issues, all students took a jointly delivered 10-credit module on RRI in Trimester Two at Newcastle. In addition to formal taught lectures, this included seminars from industry, organisations and professional bodies, so that students gained an excellent understanding of not only RRI theory, but also the practicalities involved in delivery.

2.3.2 Years 2-4: PhD in Geospatial Systems: Once graduated from the MRes, students enrolled for an individual PhD in Years 2-4, where they follow the regulations of their home institution. Interdisciplinary PhD research projects were developed and jointly supervised between students, academics, applied domain experts, and industry stakeholders. Students are encouraged to publish their research open access, from literature critique (e.g. Sutherland et al, 2023) to final findings (e.g. Walker et al., 2025). The first two completed theses from CDT PhD graduates can be found at Sanderson (2024) and Wolf (2024). A full list of projects can be found at UKRI (2026).

Members of each annual cohort continue to come together for regular bespoke CDT training in IEL (e.g. Figure 2) and RRI throughout the three years of PhD funding. IEL PhD training commences with an introductory one-day workshop on Geospatial Innovation and Entrepreneurial Thinking to ingrain a culture of innovation and entrepreneurial abilities and skills, with workshops continuing through to the end of the PhD (see Section 2.4.1). To ensure continued RRI practice, students undertake a tailored suite of training that builds upon the MRes module. This training was co-designed with, and delivered by, RRI experts with contributions from the geospatial ecosystem. At the start of the PhD, students present a RRI plan for their research (Figure 3) and maintain a portfolio of their studies.

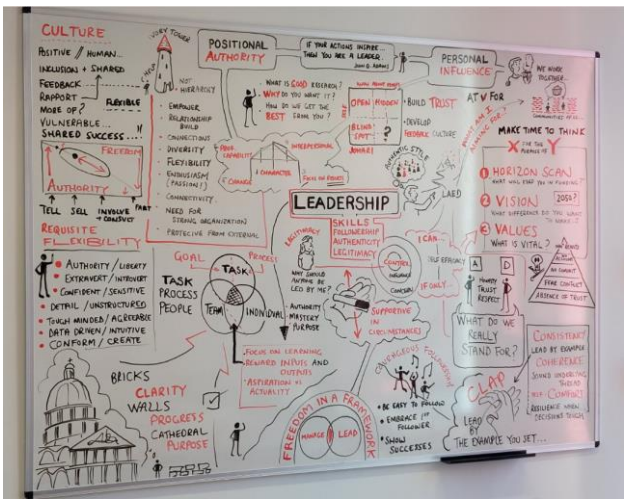

Figure 2. Development of future leadership skills forms a core element of bespoke CDT training from the MRes onwards.

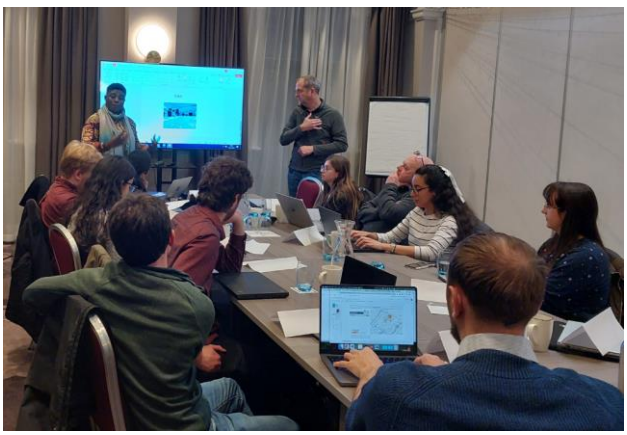

Figure 3. Cohort 5 students discuss and present their RRI PhD plans to each other at a workshop in York, December 2024.

2.4 Cohort Integration

2.4.1 Horizontal Cohort Integration: A key MRes activity involved a month-long group project to integrate the knowledge gained and skills developed in taught modules. It provided a valuable peer to peer learning experience prior to embarking on the individual MRes project. With R&D in industry often carried out across multiple spatially distributed sites, it was felt essential that students gained an appreciation of this increasingly common approach to group working. This proved particularly pertinent as the entire 2021 project was conducted on-line due to Covid-19 lockdown! Students worked in small groups, balanced across the two institutions, on a small but real-world problem (e.g. Figure 4) provided by one or more industrial partners, with in-person workshops throughout the project. Topics varied to broaden experience (Table 2) and cohort-wide publications encouraged to give students their first academic outputs (e.g. Guiney et al., 2021; Wolf et al., 2025).

Year	Topic	Industry lead(s)
2020	UN Sustainable Development Goals (SDGs)	Newcastle University
2021	Sustainability of Magna Roman Fort	The Vindolanda Trust
2022	Electrification of a full taxi fleet by 2030	Blueline Taxis / Zero Carbon Futures UK
2023	Space data for emergency management	UK Space Agency / Sat Apps Catapult
2024	Future national 3D datasets	Ordnance Survey

Table 2. MRes Group project topics by year and industry leads.

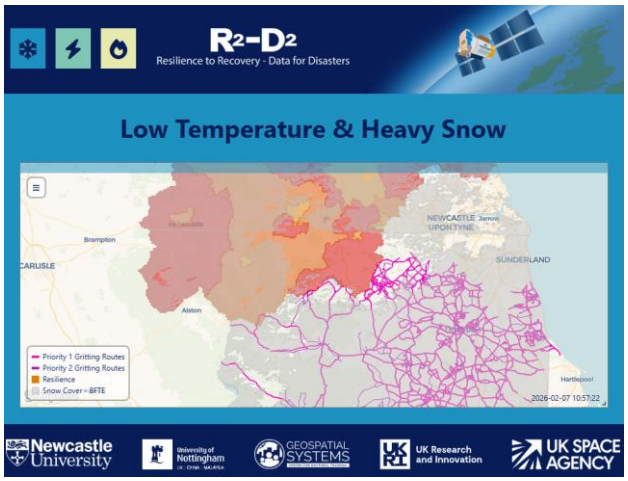

Figure 4. Prototype dashboard developed for emergency management during 2023 Group Project (Wolf et al., 2025).

Bespoke MRes modules, together with continued IEL and RRI training delivered by external trainers at various locations, supports cohorts to come together at regular points throughout their studies. IEL/RRI training concludes in the final year with a “Road Trip” to visit geospatial industry and governmental partners in the Midlands and South-East England (Figure 5).

Figure 5. The CDT final year Road Trip involves visits to partners, including the UK Government in Westminster.

The Road Trip also includes development of best practice for starting careers, including job interviews. This has proven particularly popular, with students crediting the training to helping them achieve their preferred choice of employment post-PhD. The trip also includes time for social interaction, such as driving a Formula One simulator at Silverstone (Figure 6), providing one CDT academic the opportunity to reminisce about his own geospatial training (Mills and Newton, 1994).

Figure 6. The 2025 Road Trip included a visit to Silverstone. Cohort 3 are seen here with Damon Hill’s 1996 F1 World Championship winning FW18.

2.4.2 Vertical Cohort Integration: A variety of activities foster vertical cohort integration across intakes. Amongst these, the annual Challenge Week has proven particularly effective. As per the MRes Group Project, topics vary to provide broadening, with challenges led by ecosystem partners (Table 3, Figure 7). Data and outputs are provided to industry leads to support innovation. Moreover, the Challenge Week has also led to academic outputs - e.g. Morelli et al. (2024) and Peppa et al. (2024) arose from the 2024 Challenge Week (Figure 8).

Year	Topic	Industry lead
2020	Cancelled due to Covid-19	N/A
2021	EV charging post locations	Kinewell Energy
2022	Freeport locations	AtkinsRéalis
2023	The 15-minute city	Diagonal
2024	Recreating Sycamore Gap	National Trust
2025	England’s future housing	Knight Frank
2026	NetZero via wind and solar	NDTP

Table 3. Challenge Week topics and industry partner lead.

Figure 7. Students are presented with the 2025 Challenge Week task by CDT industry partner Knight Frank.

Figure 8. Challenge Week at Hadrian’s Wall, April 2024.

The Annual Assembly (Figure 9), organised every year by the students themselves, was initially a vehicle for the in-year assessment of the MRes project work and evolved into a showcase of the CDT’s research. For example, in 2025, students worked with North-East artists to each create an artwork that represented their PhD, presenting this as a “PhD in a Picture” at the Assembly held at Nottingham Contemporary in 2025, and repeated at a Newcastle art gallery in January 2026 (Figure 10).

Figure 9. Annual Assembly in Newcastle, September 2024.

Figure 10. “PhD in a Picture” art exhibition in Newcastle, 2026.

Other activities have included an Innovation Festival, which has evolved to participation in Northumbrian Water’s Innovation Festival (NWG, 2026). The CDT also exhibits annually at GEO Business in London (GEO Business, 2026), which students are required to attend at least once during their studies to staff the exhibition stand and network with industry. Flexible funding has also allowed students to self-convene cross-cohort team building activities, e.g. residential paper writing retreats, and other events such as a seminar at COP26 in Glasgow 2021, organised jointly with the SENSE CDT from Leeds University.

2.5 Research Training Support / Other CDT Activities

All studentships were costed with a Research Training Support Grant that provides individual students c. £20k to support their training and MRes/PhD research, aligned to a Training Needs Assessment and their own MRes/PhD project proposals.

2.5.1 Placements, Conferences and Fieldwork: All students are expected to undertake an external placement of between one and three months at an international partner. Placements have been undertaken at institutions including, e.g. FGI, Ohio State University. Students are also encouraged to promote their work at conferences and often take advantage of placements to attend local meetings, improving cost effectiveness. Projects involving data acquisition have involved fieldwork across the globe, from Colombia to New Zealand.

2.5.2 Outreach and engagement: Recruitment to geospatial programmes has been a longstanding problem in the UK (e.g. Mills et al., 2004) and so students have been encouraged to promote the geospatial discipline in schools and other appropriate outlets through a dedicated EDI promotion fund. Mills et al. (2026) includes more details on activities.

2.6 CDT Governance

Overall management is conducted by a Programme Management Board (PMB), which includes the directors, training delivery experts, programme manager, and student representatives. The PMB meets formally bi-monthly to review and plan the strategic delivery of the CDT. Day-to-day management is undertaken by the CDT programme manager at Newcastle with support from an assistant at Nottingham. Students follow the regulations / policies of their home institution, including Board of Studies, Examinations, etc. An independent Industry Advisory Board (IAB) was originally populated with a combination of international geospatial academics, core industry partners, EPSRC, and student representatives. Post-Covid-19, this evolved to focus on industry relevance to ensure clear and achievable pathways to impact were achieved via academic-industry co-development. The IAB meets twice per year, including at the Assembly where the student body meets with the IAB (Figure 11).

Figure 11. CDT students meet the IAB in Nottingham, 2023.

3. CDT Student Participation and Progression

3.1 Student Recruitment and EDI Profile

Over the period 2019 – 2023, the Universities of Newcastle and Nottingham worked together with UK industry and government partners to recruit the requisite target of 50 students to the CDT over five annual cohorts. Students were recruited primarily on the criteria of academic excellence, with 28 students ultimately enrolling at Newcastle and 22 at Nottingham. With funding from UKRI back-loaded and industry budgets tightened due to Covid-19, cohort sizes grew from eight in the first cohort (2019 entry) to 13 in the fifth cohort (2023) – Figure 12.

Cohorts displayed generally high levels of diversity, especially in a UK engineering landscape. UKRI studentship eligibility rules strongly dictated the nationality of enrolments, yet the CDT still hosted students of 13 different nationalities: 36 (72%) British, seven (14%) from five different nations within the EU, and seven (14%) from countries beyond the EU (3x Africa, 2x Asia, 2x South America). Gender balance was good, with a 24 (48%): 26 (52%) female: male ratio. Five students (10%) declared their ethnicity as “Asian”, three (6%) as “Black”, three (6%) as “Mixed”, five (10%) “Not disclosed”, one (2%) as “Other”, and 33 (66%) as “White”. 32 (64%) students were in the age range 20-29 on enrolment, 16 (32%) were aged 30-39, one (2%) 40-49, and one (2%) 60-69. Six students (12%) recorded a known disability, with the remaining 44 (88%) having no known or declared disability.

3.2 Student Progression

All 50 students (100% of those enrolled) graduated at the end of their first year with a MRes in Geospatial Data Science. Two of the 50 students (4%) decided not to continue with geospatial study on graduation from the MRes and so did not register to commence a PhD. Of these, one chose to return to their former place of employment, and one moved to another PhD programme elsewhere. Of the 48 students that continued, at the time of writing (February 2026), eight (16%) have successfully graduated from the programme with PhDs in Geospatial Systems; three (6%) have passed and are pending graduation; four (8%) are under examination; 28 (56%) are still studying. Sadly, a further five students (10%) have withdrawn, bringing the total number of withdrawals since the first registrations in 2019 to seven (14%), equivalent to c. one withdrawal per annum. Cohort 4 has seen a particularly large proportion (4 of 7) of these withdrawals (Figure 12), for apparently unconnected personal circumstances. More positively, several students have received awards for their research (e.g. EuroSDR, 2025).

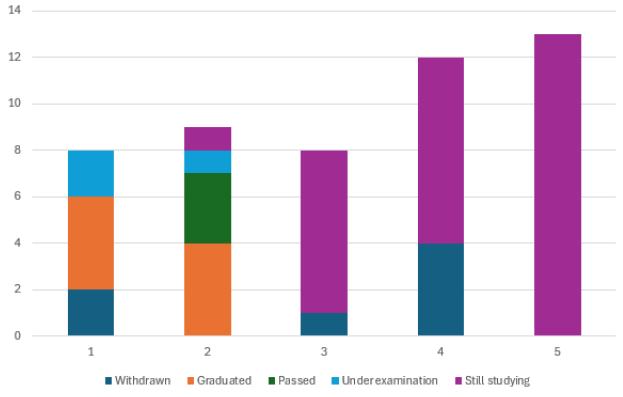

Figure 12. Student progression statistics by Cohort (Feb 2026).

3.3 First Destinations Post-PhD

Students have progressed immediately from study to a variety of first choice career destinations. In academia, CDT alumni can be found at the Universities of Glasgow, Loughborough, Newcastle, Nottingham, Sheffield, and UCL, with two graduates having secured prestigious individual UKRI funded Fellowships. In industry, at Leica Geosystems and Siemens. In government, at the Ministry of Housing, Communities and Local Government, as well as HM Revenue and Customs, Historic Environment Scotland, and East Mercia Rivers Trust.

4. Reflections and Lessons Learned

4.1 Cohort Approach to Doctoral Training

Cohort-based doctoral education is generally recognised to foster supportive peer communities, enhance engagement, and positively influence doctoral progression and satisfaction (Bista and Cox, 2014), providing emotional and academic support structures that help students develop as scholars (Paul et al., 2021). Beyond these recognised generic benefits, a cohort approach is additionally advantageous in geospatial systems since the modern-day professional workplace has evolved from focussing on a specific skill or capability (e.g. individual expertise in GNSS or EO) to delivering integrated systems solutions. Thus, whilst expert capability is still a pre-requisite, a practitioner must readily understand their place within the wider ecosystem of data, methods and applications. This necessitates an appreciation of how to operate culturally within a collaborative systems environment, working in a group whilst maintaining a distinctive individual remit to deliver specific responsibilities. Fundamentally, such training can only be delivered by a cohort approach that maximises both individual student experience, draws on the values of diversity, and delivers the requisite value-added level of understanding.

However, whist a cohort model has significant benefits and promotes collaborative scholarship that prioritizes community, reflexivity, and shared scholarly growth, such an approach also introduces tensions, e.g. in peer dynamics, and institutional capacity (Byrne et al., 2026). Whilst the ambition of a harmonious, inclusive, efficient and scholarly doctoral community is undoubtedly a laudable one, CDT experience has shown that the enthusiasm of individual students for such varies considerably, particularly when the award of an original and individual PhD is the endgame. Enthusiasm for IEL and RRI training waxed and waned for almost all. Some struggled to “remove their blinkers” for elements of group training (“what has this got to do with my PhD?”), leading to tensions, and it became necessary to introduce peer assessment into some activities to ensure everyone contributed. Some students who enrolled may have been better suited to conventional individual PhDs, rather than a cohort programme. Some also found the transition from being treated as a “taught” to a “research” student easier than others, though the cohort experience – the Group Project in particular – undoubtedly helped in this respect.

4.2 Operating a Split-Site, Multi-Partner Training Centre

The fusion of diverse scientific expertise into an integrated community is essential to creating a successful interdisciplinary CDT. To achieve this, the CDT drew on expertise from two of the UK’s leading geospatial academic groups, in consort with c. 40 international partners. A core challenge to the operation of such a “Centre” is doing so across sites spatially distanced from one another. The evolution of the workplace to more remote

working in the post-Covid-19 era mitigated this issue somewhat, creating more equitable working, but simultaneously negatively impacted day-to-day cohort experience, particularly where individual Cohorts were small at one institution.

Delivering a full, equitable training programme across two sites was a challenge, particularly with different programme regulations and small student numbers meaning much of the MRes had to draw on existing modules. Core technical training relied predominantly on local provision, leading to slight differences in expertise between Newcastle and Nottingham graduates. Training necessarily evolved over time; e.g. although AI was prioritised in the 2018 bid, the global day-to-day impact it enjoys in 2026 was underestimated, necessitating a shift in the focus of the CDT to developing AI-capable leaders. Providing a coherent RRI programme throughout was also problematic, with no single provider covering all needs, one withdrawing from the market, and poor student feedback on an initially recommended course. Whether the 1+3 model is a beneficial one is debatable. Many students valued the intensive training in a new field, which supported recruitment and provided an additional qualification demonstrating geospatial capability to industry partners. It also enabled topic changes after the MRes and offered an exit award for those who withdrew. However, some disliked “starting again” in Year 2 and felt they had only three funded years for a PhD that typically takes four. The model also created significant academic and administrative overheads.

4.3 National and Global External Influences

4.3.1 Brexit: The UK’s withdrawal from the EU was implemented on 31 January 2020, five months after enrolment of Cohort 1. Brexit fundamentally changed student funding eligibility with almost immediate effect. After Cohort 2, for which EU students were still classed equivalent to “home” UK students in funding eligibility terms, EU students were regarded as “international” by UKRI. With only 10% of CDT intake (c. one student per cohort) permitted to be international, and with strong outside competition for a limited pool of national talent with interest in PhD study, recruitment to achieve an excellent, diverse intake in all remaining cohorts proved exhausting.

4.3.2 Covid-19 Pandemic: Immediately after Brexit, and within the CDT’s first year, the Covid-19 pandemic struck. UK lockdown restrictions, introduced in March 2020, were frequently severe and had a direct and detrimental impact on the student experience of the first two cohorts, with disruptions continuing until mid-2021. Cohort 2, for example, did not meet in person until eight months after enrolment; all training and cohort activities were delivered remotely during this period. The wider effects of the pandemic on student wellbeing are well documented. For instance, Son et al. (2020) identified heightened stress, anxiety, depressive symptoms, sleep disturbance, and academic concerns linked to lockdowns, campus closures, and the rapid shift to remote learning. Although only one early withdrawal from the CDT is thought to have been indirectly attributable to Covid-19, the pandemic inevitably disrupted fieldwork, conference participation, and other core elements of geospatial training. These constraints led to multiple PhD extensions among students in the early cohorts.

Whether Covid had further negative long-term impacts on the CDT can only be hypothesised. For example, whilst cohort training is recognised to improve student motivation and resilience, which potentially contributes to higher completion rates (Byrne et al., 2026), the unprecedented number of withdrawals from Cohort 4 (Figure 12) may well be partially due to students becoming “tired” of learning due to their prior Covid-impacted educational experiences. Moreover, it certainly proved difficult to engage industry in many CDT activities during and immediately post-Covid, e.g. the Innovation Festival struggled to attract participants. Taking final year students on the first Road Trip to physically visit partners in January 2022 undoubtedly reignited industry interest in the CDT post-Covid.

4.3.3 Financial Impacts: There were also significant financial impacts of Covid-19 and Brexit that affected UK higher education. Nottingham lost several staff as a direct result of a Covid provoked voluntary severance scheme operated by the University in the first year of the CDT. More recently, the current funding crisis affecting UK higher education has also had profound impact on CDT operations, with voluntary severance “opportunities” resulting in several key CDT academic staff members leaving or retiring from both Newcastle and Nottingham. Such events have exacerbated the inevitable staff churn that naturally occurs in regular day-to-day ephemeral academia over the course of running a protracted eight-year endeavour. Moreover, a UK cost-of-living crisis has endured for several years now, and several departing students cited their primary reason for withdrawal (and one moving part-time) as needing to earn more money. UKRI has recognised this issue and increased stipends significantly year-on-year as a result. Finally, financial and operational pressures faced by industry partners have impacted the co-development of research projects through the lifetime of the CDT, with the traditional PhD model of a single 3-year+ linear programme of work evolving to a more flexible model. This is likely to continue to evolve given the wider UK research funding landscape at present.

4.4 Value for Money and Future UK Geospatial Capacity

Cohort-based training models require substantial resources, without which they risk inconsistent participation, disengagement, and unsustainable workloads for academics and students (Byrne et al., 2026). The CDT was fortunate to achieve investment of c. £7M from UKRI (further bolstered by c. £4M from the geospatial ecosystem), so each of the 50 recruited students represents a UK taxpayer investment of c. £140k. However, as these graduates advance into senior leadership positions over the coming decades, the collective community created by the CDT is expected to sustain the UK’s international competitiveness in geospatial systems. When considering the likely return, the £140k per head investment appears relatively modest (especially when compared to nations with larger research and innovation budgets). However, such training is unsustainable, and many elements of the developed model are untransferable, without the level of resource provided. To this end, the CDT team bid for a new centre in 2023. Unfortunately, the proposal was ultimately deemed “fundable but not a priority” by UKRI and, with too many strong bids to support – notably with the continued emergence of AI – went unfunded. For comparison to the details reported herein, a full list of UKRI AI CDTs can be found at UKRI (2023). Nevertheless, the CDT experience and the lessons learned regarding the future of the discipline – e.g. AI ascendency – has been invaluable and given rise to further training initiatives, e.g. a new Newcastle University MSc programme in Geospatial AI (Geo-AI, 2026).

5. Conclusion

The EPSRC CDT in Geospatial Systems has successfully established itself as an internationally recognised centre of excellence in doctoral education, creating a national cohort of researchers equipped with the capabilities to lead and shape the

opportunities arising from the open geospatial data and Geo-AI revolution, thereby maintaining UK competitiveness in a critical global profession. Through close collaboration with industry and user communities, the programme aligned doctoral research with UK priorities, supporting the effective use of big data, cloud computing, AI, and IoT to drive innovation and growth. It fostered a collaborative, cohort-based research culture with peer learning at its core, alongside industry-informed training in IEL and RRI to translate research into operational and commercial outcomes. Impact was strengthened through sustained external engagement, while EDI principles enhanced research capability by valuing diverse life experiences. International partnerships further addressed interdisciplinary economic, societal, and environmental questions. Despite challenges, delivering the CDT has ultimately been a highly rewarding experience. Further details of the CDT are available at GS-CDT (2026).

Acknowledgements

The EPSRC CDT in Geospatial Systems is funded by UKRI (EP/S023577/1), with multiple additional studentships provided by Airbus Defence and Space, DSTL, Ordnance Survey, Network Rail and the UK Hydrographic Office. The authors would like to thank these and all other organisations that have provided funding, time, data, software, and other multi-faceted contributions to the CDT endeavour, including the CDT’s IAB which has been independently chaired, first by Dr Anne Kemp and latterly by Dr Vanessa Lawrence CB. Thanks are due to academic colleagues who have participated as PMB members, trainers, and supervisors in the CDT, as well as all the amazing support staff who have endured both academics and students alike. Finally, thanks to the 50 students who enrolled in the CDT – it is a privilege to be part of your incredible journeys.

References

Bista, K., Cox, D. W., 2014. Cohort-based doctoral programs: What we have learned over the last 18 years. *International Journal of Doctoral Studies,* 9, 1-20.

Byrne A-L., Flenady, T., Wise, I., Nijkamp, N., Zupan, B., 2026. Cohort supervision and pedagogy in higher degree research: rethinking the dyadic model. *Frontiers in Education,* 10(2025).

EuroSDR, 2025. EuroSDR PhD Award Winner 2024. www.eurosdr.net/news/eurosdr-phd-award-winner-2024 [last accessed 8 February 2026].

Geo-AI, 2026. Geospatial Artificial Intelligence MSc. www.ncl.ac.uk/postgraduate/degrees/5540f [last accessed 8 February 2026].

GEO Business, 2026. GEO Business: The Geospatial Event. www.geobusinessshow.com [last accessed 8 February 2026].

Gov-UK, 2017. Chancellor to unlock hidden value of government data. www.gov.uk/government/news/chancellor-to-unlock-hidden-value-of-government-data [last accessed 8 February 2026].

GS-CDT, 2026. Geospatial Systems Centre for Doctoral Training. geospatialcdt.ac.uk [last accessed 8 February 2026].

Guiney, R., Santucci, E., Valman, S., Booth, A., Birley, A., Haynes, I., Marsh, S., Mills, J., 2021. Integration and analysis of multi-modal geospatial secondary data to inform management of at-risk archaeological sites. *ISPRS International Journal of Geo-Information,* 10(9), 575.

Medha, T., 2025. Centres for Doctoral Training (CDTs) and Doctoral Training Partnerships (DTPs) - A Guide. www.findaphd.com/guides/phd-study-in-uk/cdts-and-dtps [last accessed 8 February 2026].

Mills, H., Robson, C., Linighan, A., Edwards, S., Larkin, C., 2026. Geospatial UK Higher Education – status, challenges, and outreach initiatives. *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.,* In press.

Mills, J., Newton, I., 1994. Surveying in motor sport. *Survey Review,* 32(254), 485-494.

Mills, J. P., Parker, D., Edwards, S. J., 2004. Geomatics.org.uk: A UK response to a global awareness problem. *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.,* 35(B6), 1-6.

Morelli, L., Mazzacca, G., Trybała, P., Gaspari, F., Ioli, F., Ma, Z., Remondino, F., Challis, K., Poad, A., Turner, A., Mills, J. P., 2024. The legacy of Sycamore Gap: The potential of photogrammetric AI for reverse engineering lost heritage with crowdsourced data. *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.,* XLVIII-2-2024, 281-288.

NWG, 2026. Northumbrian Water’s Innovation Festival. www.innovationfestival.org [last accessed 8 February 2026].

Paul, P., Olson, J.K., Spiers, J., Hyde, A., 2021. Becoming scholars in an online cohort of a PhD in nursing program. *Int J Nurs. Educ. Scholarsh.,* 18(1).

Peppa, M.V., Morelli, L., Remondino, F., Mills, J.P., 2024. 3D geometric assessment of a commercial RTK/PPP visual positioning mobile sensor. *Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci.,* XLVIII-2/W7-2024, 97-104.

Sanderson, R.K., 2024. Understanding the geographies of left behind places using geospatial data. *PhD thesis, Newcastle University.* theses.ncl.ac.uk/jspui/handle/10443/6357 [last accessed 8 February 2026].

Son, C., Hegde, S., Smith, A., Wang, X., Sasangohar, F., 2020. Effects of COVID-19 on college students’ mental health in the United States: Interview survey study. *Journal of Medical Internet Research,* 22(9), e21279.

Sutherland, N., Marsh, S., Priestnall, G., Bryan, P., Mills, J., 2023. InfraRed thermography and 3D-data fusion for architectural heritage: A scoping review. *Remote Sensing,* 15(9), 2422.

UKRI, 2023. UKRI AI Centres for Doctoral Training. www.ukri.org/who-we-are/our-vision-and-strategy/tomorrows-technologies/how-we-work-in-ai/ukri-artificial-intelligence-centres-for-doctoral-training/ [last accessed 8 February 2026].

UKRI, 2026. UKRI Gateway: EPSRC Centre for Doctoral Training in Geospatial Systems. gtr.ukri.org/projects?ref=EP%2FS023577%2F1 [last accessed 8 February 2026].

Walker, R.Z., Boyd, D.S., Andersen, R., Large, D.J., 2025. InSAR Coherence linked to soil moisture, water level and precipitation on a blanket peatland in Scotland. *Remote Sensing,* 17(21), 3507.

Wolf. K., 2024. Geospatial data infrastructure for multi-agency incident management. *PhD thesis, Newcastle University.* theses.ncl.ac.uk/jspui/handle/10443/6379 [last accessed 8 February 2026].

Wolf, K., Mills, J.P., Cormier, L., Dunn, R., Fairless, O., Falaye, A., Gordon, S., Jayamanne, O., Morris-Wiltshire, C., Myall, E., Salgado-Castillo, F., Shukla, Y., Taylor, L., Robson, E., Donoghue, D., Dawson, R.J., Lewis, E., Reaney, S.M., Scott, E., Freedman, J., Marshall, S., Walker, P., Hinds, H., 2025. Capability analysis of Earth observation data for integrated emergency management. *Remote Sensing,* 17, 1545.