

Centre for Satellite Data in Environmental Science (SENSE) (SPA0040)

Evidence on the UK's Engagement with Space – NERC SENSE CDT

This document is written evidence submitted to the House of Lords Committee on UK Engagement with Space, through their March 2025 enquiry on UK policies relating to Space. This evidence is written by Dr Heather L. Selley, Prof Anna E. Hogg, Prof Kathy Whaler OBE, Dr Encarni Medina-Lopez and Prof. Phil Livermore in their capacities as the Centre Manager, Directors and Deputy Directors of the Natural Environment Research Council (NERC) Centre for Satellite Data in Environmental Science (SENSE) Centre for Doctoral Training (CDT). The SENSE CDT is an exciting centre funded by NERC and the UK Space Agency (UKSA), which has funding for 70 PhD students over 4 cohorts to tackle cross-disciplinary environmental problems, by applying state-of-the-art data science methods to the wealth of satellite data collected each day. The SENSE CDT programme is a collaborative initiative led by the Universities of Edinburgh and Leeds in partnership with the British Antarctic Survey (BAS) and the National Oceanography Centre (NOC). We have internationally recognised expertise in the use and training of the next generation of experts in Earth Observation (EO) data.

This evidence is structured according to the questions raised in the Committee's call for evidence. We have only answered the questions most relevant to our expertise.

The opportunities and challenges relating to the UK space sector

A key challenge we repeatedly see in the UK Space Sector is the lack of an appropriately trained workforce, particularly the ability to analyse EO data to monitor and enforce policy to quantify, address and mitigate biodiversity loss, climate change, natural hazards, land use change and greenhouse gas emissions. By training a new generation of industry-experienced satellite data specialists, SENSE supports the growing strategic importance of remote sensing within the UK space sector and enhances the UK's profile as an international leader in EO science. The findings of the 2021 UK Space Agency's (UKSA) *Space Sector Skills Survey* suggested that current skills shortages jeopardize scientific advancements, delay the adoption of emerging technologies, and slow the growth of space-related companies.

This has remained consistent through to the 2023 UKSA *Space Sector Skills Survey* despite further investment including into the SENSE CDT.

There is a long lead time to upskill the workforce with the PhD Researchers funded through SENSE CDT only just beginning to graduate. We continue to see enquires about PhD projects and opportunities to attend training with the SENSE CDT despite having completed recruitment in 2023. This highlights a core issue that the funding for CDTs, such as SENSE, to fulfil this training need are only short-term and the necessity for a longer-term mechanism to fully address the skills gap. The UKSA survey shows 157 organisations reported a skills gap in software and data, even if each organisation only required one individual skilled in EO the 70 upcoming graduates from SENSE CDT would not be sufficient to address even half the deficit, with the likely actual number of specialists required to be much higher. This aligns with our recent market research with industry highlighting again the necessity for specialist skills in EO.

Machine learning and data-driven methods are having a profound impact on the field of EO in industrial applications with the state of the art rapidly evolving, presenting the opportunity to develop on the strong foundations cultivated through specialist programmes such as the SENSE CDT to ensure the UK has the skilled workforce to be at the forefront and competitive in the EO sector. Further and sustained investment in training is essential for this aim to be realised.

3. Existing international partnerships that the UK is involved in, and the potential for future partnerships with both state and commercial actors.

SENSE has had three students participate in international industry placements with ENVEO, NASA Goddard and IsardSAT organizations, with three more undertaking placements with international offices including Spire and UniLever. We have 34 Collaborative Awards in Science and Engineering (CASE) partners that provide doctoral students with research training experience as part of a research collaboration between academic and non-academic partner organisations. This includes for SENSE CDT PhD Researchers a financial contribution of at least £1K per annum for the duration of their studies. SENSE also has Co-Supervisors at 15 international universities and institutes in addition to 18 across the UK.

6. The collaboration between academic institutions, government, and commercial space firms in the UK, including but not limited to space research and development and space spin-out and start-up firms.

The SENSE CDT programme is a collaborative initiative led by the Universities of Edinburgh and Leeds in partnership with the BAS and NOC. As such, it is a strong example of collaboration between academic institutions, government, and commercial space firms through CASE partnerships in the UK. The Centre creates a multi-disciplinary training environment for doctoral students to engage in EO-focused research areas, develop EO techniques, and an understanding of the practical applications of satellite data in close collaboration with industry and government. We have over 40 industry partners and 34 CASE partnerships across the UK and internationally. SENSE host an annual Industry Symposium welcoming existing and new partners in the space sector to connect with our PhD Researchers, including utilising a space sector company to facilitate our most recent event. We have strong international connections particularly with the European Space Agency (ESA) who we regularly work with for training opportunities and events including specialist EO training workshop pilots which are now embedded within their annual programme along with key skills development such as training on writing Invitations to Tender (ITTs).

7. Education and skills; in particular the skills gap in the UK space sector.

Earth Observation (EO), as a key segment of the space sector, is subject to skills shortages, particularly in data analysis. Companies identified through the space skills survey the greatest gap in software & data skills (72%), significantly higher than any other technical area. This is partly driven by a need for skills in AI & machine learning (41%) and data analysis & modelling (36%) (UKSA Space Skills Survey, 2023). This is supported by our recent market research exploring the training needs that the development of SENSE CDT training materials could help to address through upskilling the current workforce. Discussions covered key points such as the relevant knowledge or skills needed, the current level of employee expertise, critical aspects of the training, the depth of knowledge expected, and the preferred programming language for the course. We found that there is demand for Continued Professional Development (CPD) training in Earth Observation, particularly in areas such as EO with remote sensing applications, machine learning with EO, and advanced tools and services for working with EO data.

There is a clear need for employees to learn foundational remote sensing protocols within EO and machine learning, particularly to equip them with the skills and confidence to set up machine learning projects to address their work challenges. The common goal was for employees to become self-sufficient, able to write their own code, and develop a strong understanding that would enable them to continue learning independently. Importantly, it was rare that employees had both the programming skills combined with EO knowledge to effectively undertake projects. Some companies also saw value in an introductory EO course for business and sales teams, providing them with essential knowledge for engaging clients during sales visits.

In addition to training focusing on industry, there remains the skills need for specialists trained to a PhD level. We continue to see regular requests for training from non-SENSE CDT PhD researchers and enquiries about if SENSE CDT will be recruiting. This aligns with our previous recruitment rounds with over 800 applications for 70 PhD studentships. Although all CDTs are limited in scope, we were fortunate to obtain additional funding from the Department for Science, Innovation and Technology (DSIT) through an EO Investment Package (EOIP) responding to a desire to support the EO sector when the UK suspended its association with Copernicus in 2020 because of Brexit. This funding supported 19 new PhD studentships in 2023/2024, focused on developing EO skills in environmental science, data science, AI and machine learning, that are relevant to public and private sector contexts. However, there is currently no more funding to recruit further PhD researchers which would be a clear pathway to upskilling and contribute to fulfilling the skills needed in this rapidly expanding and specialist field that has wide-reaching impacts. These PhD projects promote research-industry collaborations and effective knowledge transfer in EO through integrated industry placements and symposia.

Through the EOIP funding we enabled PhD researchers outside of the SENSE CDT to attend our 2023/2024 training programme which received over 120 applications. We were able to provide training to 91 early-career PhD students from 33 institutions (32 universities plus the British Antarctic Survey) outside the SENSE CDT programme in 2022-2024. The training covered a range of subjects, including Python programming, statistics, Machine Learning, working with large datasets, EO of the Atmosphere,

Cryosphere, Biosphere, Oceans and Solid Earth, and field skills. Additionally, the Continued Professional Development (CPD) provision included careers planning training attended by 22 professionals in EO. As we are no longer recruiting, the training has not been delivered since 2024.

A common thread of the evidence given above is that there remains a large skills gap in Earth Observation, despite the success of our CDT (SENSE) in this topic. The 70 students with specialist training will be a welcome, but relatively small addition, to the UK workforce. There are two principal ways we can better fill the skills gap: train more students or offer professional training (CPD) to companies or organisations to upskill their work force. CPD is arguably a natural way for universities to work with organisations to offer them the training they need, but universities need budgetary support to get such programmes off the ground, as financial pressures generally leave CPD as low-priority.

8. The future of UK space science and civil exploration.

The integration of machine learning and AI into Earth Observation (EO) has the potential to accelerate simulations, enhance models, and develop imaging tools that identify key features within EO data. In discussions with various industry partners, there was a strong desire to explore how machine learning can be applied to existing EO and remote sensing tools. There was also a notable demand for advanced EO tools and services, particularly those focused on handling big data and leveraging cloud-based processing. This has large potential to improve monitoring and forecasting of the environment through more accurate, faster approaching near-real time and at smaller scales than ever before.

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