Response from the Royal Geographical Society (with IBG)

Royal Geographical Society with IBG

Advancing geography and geographical learning

National Data Strategy open call for evidence

The Royal Geographical Society (with The Institute of British Geographers) (RGS-IBG or "we") welcomes this opportunity to respond to the Department for Culture, Media and Sport's open call for evidence to inform the National Data Strategy.

The Society is the learned society and professional body for geography and geographers. It was founded in 1830 for the advancement of geographical science and has approximately 16,000 members.

Geography is the integrated study of the Earth's landscapes, peoples, places and environments. Geographers specialise in the dynamics of these phenomena, with skills based in quantitative and qualitative methods in the natural sciences, social sciences, and humanities. Geographers are ideally placed to relate to many other fields of knowledge, which includes the increasingly complex relationship between location data/geospatial data approaches and techniques, big data analysis, and broader technological and digital advancement in the collection, use and storage of data.

The Society awards Chartered Geographer, the only internationally recognised professional accreditation for those with competence, experience and professionalism in the use of geographical knowledge, understanding and skills in the workplace. Chartered Geographers may choose to adopt a post-nominal in GIS (e.g. CGeog(GIS), to signal specialist expertise in the use and application of geographical information science/systems, the use of geospatial data.

Geospatial data is information about *where* people and objects are in relation to a particular geographic location at multiple scales (local to global). This includes features on or near the earth (gathered via direct observation and remote sensing) or in space (through satellites). The terms 'located' or 'location' data, 'spatial' data, and 'geographical information' are used throughout our response to refer to geospatial data, but we appreciate that some or all of these terms may have specific meanings to other groups and would welcome the opportunity to develop a shared glossary of terms.

For further information regarding this response, please contact Dr Stephanie Wyse, Professional and Policy Manager (policy@rgs.org).

People

Objective 1. To ensure that data is used in a way that people can trust

Research area: opportunities and barriers to trust

1.1. How can organisations (private, public or third sector) demonstrate trustworthiness in their use of data?

1.2. How easy is it for the public to find about how information provided to or inferred about them by an organisation is being used?

1.3. Are organisations (private, public or third sector) using personal data in ways that may damage trust?

Data can be used to deduce someone's background, religion, political beliefs, gender identity, and even medical conditions. One of the key tools for doing this is through the routine collection of location (also known as geospatial) data (for example, from administrative data, individuals' phones, electronic devices, travel and financial transactions).

We have observed that to date a person's location does not appear to have received the same level of scrutiny as other aspects of personal data. The ways in which we collect, use and store location data is associated with numerous ethical issues – the means by which is it collected, the degree to which consent is obtained, and, crucially, how that data is shared as a public and/or commercial resource.

Location is a fundamental component of personal identity and behaviour, and is a key, and novel, aspect to the plethora of data being created. Some of the most interesting and relevant examples which brings these potential issues to life include: *Your apps know where you spent the night* (New York Times, 2018: https://www.nytimes.com/interactive/2018/12/10/business/location-data-privacy-apps.html) and *Fitness tracking app Strava gives away location of secret US army bases* (The Guardian, 2019: https://www.theguardian.com/world/2018/jan/28/fitness-tracking-app-gives-away-location-of-secret-us-army-bases).

In statistics, spatial disaggregation, which is now easily done, can lead to identification of individuals through location/location identifiers. Growing AI capability will make it increasingly feasible to identify an individual from anonymised data by scraping and processing location-based information from various sources. This is a topic which requires further consideration if innovators are to be able to use the location attributes of data legally and ethically. Personal location data needs to be carefully managed within future AI applications if it is not to infringe personal privacy, even inadvertently, e.g. through the meshing of datasets collated at a range of scales.

1.4. In what ways are companies making money from personal data? How profitable are these activities?

Research area: concerns around trustworthiness

1.5. Do people know how information provided to, or inferred about them by, an organisation (private, public or third sector) is being used, stored and shared?

We note the work by the Open Data Institute on the UK's geospatial data infrastructure, which comments on ensuring ethical and equitable practice to geospatial data (Open Data Institute, 2018: https://theodi.org/article/geospatial-data-infrastructure-report/), in particular the potential risks for personal data relating to the ubiquity of mobile and sensor devices capable of communicating location data with ever-greater precision.

It is essential that individuals understand that location data shared through a digital device, especially when combined with other online communications or transactions, may reveal aspects of their identity, character or behaviour that they may wish to keep private.

1.6. To what extent are people concerned about how data about them is used, stored and shared? Are some groups more concerned than others? Are there particular categories of data that raise more concerns than others?

We note the research by HERE Technologies, which highlighted that many people feel concerned about sharing location data and do not trust how it is being used or that it is adequately protected (Geospatial World, 2018: https://www.geospatialworld.net/blogs/is-your-location-data-safe/).

1.7. What commercial practices or behaviours have affected trust in the use of personal data? Have targeted advertising and 'recommending' affected trust?

1.8. Have the General Data Protection Regulation (GDPR) and Data Protection Act 2018 made people more concerned about how personal data is managed? How has it influenced their behaviour?

1.9. How far do existing protections, such as in the Data Protection Act, go in promoting transparency and trust? What, if anything, should the government do to further build trust?

International comparisons

1.10. Are there robust international comparison measures of trustworthiness in how data about individuals is used? Which are the most effective?

Objective 2. To ensure that everyone can effectively participate in an increasingly data-driven society

Research area: managing personal data

2.1 Are people aware of how to manage personal data about them? Do they know about tools to control access?

Ofcom's Communications Market Report (OfCom, 2015: https://www.ofcom.org.uk/__data/assets/pdf_file/0022/20668/cmr_uk_2015.pdf) reports that more than two-thirds of UK adults now own a smartphone, and that: maps are the third most popular app download to smartphones (after social networking and weather), with 66% of smartphone users with 4G connectivity use online maps [the third most popular online activity behind general web browsing (81%), downloading apps (70%), and ahead of online banking (55%), making purchases (55%) and uploading photos/video content (51%)]. This level of engagement with location data, digital maps and navigation represents a significant and essential element of engagement with personal data.

We suggest further attention is needed to developing skills and knowledge around location data and privacy. Advances in how data are used, and the technologies that lie behind such data, are transforming the world as we know it. Understanding, anticipating and responding to emerging ethical issues raised by rapidly-developing technologies such as AI and the ever increasing availability of data are critical. It is essential that individuals understand that location data captured or shared through a digital device, especially when combined with other online communications or

transactions, may reveal aspects of their identity, character or behaviour that they may wish to keep private.

The steps required to prevent location data sharing within mobile devices can vary by platform/OS, device, or app/service. Furthermore, tools within those to manage the sharing of location data may not fully prevent devices or apps from tracking location, and extra steps may be required to delete data, see for example location data generated by GoogleMaps, which now has over one billion worldwide users: The Guardian, 2018 - https://www.theguardian.com/technology/2018/aug/13/google-location-tracking-android-iphone-mobile; TechRepublic, 2019 - https://www.techrepublic.com/article/how-to-stop-google-from-tracking-and-storing-your-locations/.

Research area: inclusivity

2.2 How does effective participation and data use differ by location and demographic group across the UK? What does this look like in urban areas, rural areas and more remote parts of the country?

2.3 How does effective participation and data use differ by sector?

2.4 What barriers to participation do different groups face? How are marginalised and vulnerable groups affected?

2.5 What can government do to support those in marginalised and vulnerable groups? What elements of our digital society would most benefit these groups?

Research area: data skills and employment

2.6 How important are basic data skills for employment in today's economy? What is the basic level of data skills needed and what kinds of skills are needed?

There are many benefits to building data skills in the UK population, including helping citizens to participate more fully in the democratic process; enhancing research in universities and in the workplace; and supporting the economy, taking advantage in particular of the advent of "big data". A co-ordinated and continuous effort at improving data skills across all phases of education and employment, across the whole of the UK, is therefore now urgently needed.

The ubiquity of data makes it vital that citizens, scientists and policy makers are fluent with numbers and data in all its forms. There is a huge opportunity for those who are equipped and ready to take advantage of the data revolution that is already well underway. We encourage the Department to refer to the Royal Society's *Dynamics of Data* Skills report and case studies (Royal Society, 2019: https://royalsociety.org/topics-policy/projects/dynamics-of-data-science/); the case studies showcase the Society's work in embedding data skills into the geography curriculum (also see our response to 2.9). The British Academy's *Count Us In* report (British Academy, 2015: https://www.thebritishacademy.ac.uk/sites/default/files/Count-Us-In-Full-Report_0.pdf) articulates the benefits of enhanced data skills and specific applications of those skills with reference to arts, humanities and social sciences.

By data skills, we refer to the ability to understand and interpret (reason) using numbers, which might be within specific disciplinary, applied or research contexts. These might range from basic arithmetic to handling advanced statistical analysis, including across multiple data sets. Among other things, the possession of these skills allows for: confidence in the manipulation of numbers; an understanding of the possibilities and limits of measurement; and understanding the role of evidence in testing and modifying our understanding of social processes.

With respect to geospatial data, skills need to be developed not only for the creation, curation and assurance of geographic information, but also critically with the contextualisation, analysis, interpretation and use of this information. This is where geography – and its spatial lens - has a particular role to play in unlocking the value of located data, especially in relation to other datasets.

We also consider the understanding and application of data ethics to 'big data' an essential data skill. With a growing attention to user consent and users holding companies accountable for how their data are used, it will be increasingly important for companies using personal data to clearly establish what and how data are being used, and be attentive to the possible (including inadvertent) implications for privacy of combining one data set with another.

In terms of AI, the teams that create technologies drawing upon datasets with personally identifiable characteristics, including location, will need to be as diverse as the communities that will eventually use them. It is technically difficult to retrofit ethics and transparency into existing tools and models, but technology testing protocols that currently look at usability, flaws and security could be expanded to test for fairness, bias and ethical implementation.

2.7 In which professions are data skills most important?

There are many professional bodies and other organisation supporting the ecosystem of geospatial skills – from data science, to engineering, to design and beyond. All of these all are critical. However, producing and consuming geospatial data intelligently, and interpreting it to unlock economic value and deliver social benefits, does require specialised skills. These skills are needed not just by technical specialists but also (and critically) by decision-makers and consumers of geospatial data, analysis and insights.

Geography has and will continue to play a crucial role in the delivery of geospatial and broader geographical skills of interpretation and analyses. These core skills and competencies need to continue to be cultivated, supported and developed, embracing new technologies and approaches, and the ubiquity (and multiple sources) of spatial (geographic) information. The Society has worked to support such skills across school and higher education, and with the wider professions.

We welcome opportunities to work with DCMS, BEIS, DfE, the Geospatial Commission, and the geospatial and geographical communities broadly, to develop and signpost existing and new opportunities.

2.8 Are the relevant skills available and supported where they're needed?

Attention and focus is needed at multiple levels, from schools through advanced research training, delivered in different formats to meet the needs of learners and professionals. Investment is needed in 'core' areas (such as geography, geomatics, surveying etc), but also new and emerging areas (including data science) and with different user communities (e.g. disaster response and risk management, finance etc). Skills need to be developed not only for the creation, curation and assurance of geographic information, but also critically with the contextualisation, analysis, interpretation and use of this information. This is where geography – and its spatial lens - has a particular role to play.

Numerous reports have been published based on skills needs and gaps based on employment data, surveys and interviews. Common themes relate to the lack of digital/data skills generally; to the lack of knowledge of geospatial concepts (and implications for geospatial data) amongst computer scientists, software engineers and data analysts; and to the lack of data science skills (coding, visualisation, database management etc – noted above) amongst those trained through 'traditional' geospatial routes (geodesy and surveying, cartography, GISc etc).

A stronger evidence base of needs and gaps is critical to ensuring programmes are in place such that the right skills are anticipated, cultivated and delivered for entrants at all levels in employment.

We draw specific attention to the exciting opportunities offered by the innovative methodology developed by Nesta, which involves (near) real-time analysis of job advertisements (ca 41 million to look at skills and skills clusters and employment sectors (see the accompanying document for more details). Such results could be overlain on local authorities/journeys to work to gain insights into the regional pattern of demand and/or to draw on information in other R&D platforms (glassAI, GITHUB, academic papers etc). We encourage the Department to work with the Geospatial Commission and Nesta, amongst others, to use this approach, modified slightly, to gain new insights into existing and emerging skills needs and gaps. Key to this would be the development and use of a shared and dynamic taxonomy of [geospatial] data skills and job types.

2.9 Is industry able to provide the relevant skills or is further skilling needed through the education system?

Maximising the value of geospatial data needs further investment, in 'core' areas (such as geography, geomatics, surveying etc), but also new and emerging areas (including data science) and with different user communities (e.g. disaster response and risk management). Skills need to be developed not only for the creation, curation and assurance of geographic information, but also critically with the contextualisation, analysis, interpretation and use of this information. This is where geography – and its spatial lens - has a particular role to play.

We therefore advocate an integrated approach of skilling and re-skilling for data skills, especially those for unlocking the value of geospatial data and offering geographical insight, across the education system and at a variety of levels.

In schools

Foundational skills and awareness of the value of data and geospatial insights must start in the earliest stages of education in schools. Currently, geography is the only statutory school subject in which geospatial skills are embedded and which also requires extensive data/quantitative skills too. Teaching about geospatial skills is delivered in UK schools almost exclusively through geography. Thus the study of geography is a key vehicle to educate and inspire young people about geospatial and data skills broadly defined.

Recent revisions to the curriculum at KS3 (where geography is part of the statutory national curriculum in English schools and thus taken by all students), at GCSE (ca 250,000 students taking this qualification each year; currently the 6th most popular GCSE); and at A-level (ca 37,000/yr) (one of the top ten A-levels) have enhanced the coverage and demand for data skills generally, and geospatial skills, analysis and applications specifically. This geospatial content is part of the taught courses and also included within the assessment frameworks for GCSE and A-level.

Policy interventions, notably the inclusion of geography GCSE in the English-baccalaureate, have encouraged more students to study geography at GCSE in England, with candidate numbers at a 19 year high. This is not the case in Wales, Scotland and Northern Ireland, where entry rates for this subject have declined. Opportunities to encourage broader uptake to GCSE (or equivalent) should be explored and encouraged with the respective devolved school educational administrations. Many teachers lack experience and confidence in the delivery of the content of the new school level curriculum; they need more training, resources and support in delivering the richer data content in inspirational ways.

A national programme to deliver teacher-CPD, resources, networking and mentoring is needed for teachers of geography in schools. Since 2016 the Society has been supported by the Nuffield Foundation to deliver such a series of events and resources for 1,000 teachers to support the teaching and learning of digital skills generally, as demonstrated in our *Data Skills in Geography Project Review* (RGS-IBG, 2019: (https://www.rgs.org/CMSPages/GetFile.aspx?nodeguid=49842c34-e1df-4210-8c3d-6e6059a821dd&lang=en-GB).

Geography has a shortage of specialist teachers. DfE are funding Geography Initial Teacher Training Scholarships through the Society. With this too, there is scope to support more training in geospatial skills, more awareness of applications and opportunities, and thus enhance the learning and understanding of young people. In addition, beyond geography, opportunities exist, but more support is needed, to champion cross-school (cross-subject) initiatives to introduce core concepts of spatial data through other subjects (e.g. mathematics, computer science, design, economics, biology, business studies etc). The Society has supported engagement between geographers and other subject teachers to explore such partnerships, but these need to be scaled up and other subject associations and teacher-bodies need to be engaged.

The Society has worked closely with Esri UK through the launch and roll out of a programme (from April 2017) to make ArcGIS Online freely available to all UK secondary schools, attempting to remove two barriers - installation and cost. They also launched the Geomentors programme, working with the Society to network geospatial professionals (those with expertise) with teachers, along with resources, to support the teaching and learning of GIS. These initiatives are also championed through events such as GIS day and training workshops for teachers. These programmes have been well received and successful. To date there has been uptake of ArcGIS Online in >2,000 UK secondary schools, benefiting >90,000 students. This is the order of a fifth of secondary schools across the UK. Clearly, and importantly, there are opportunities to do more: ca. 80% of secondary schools are not accessing these resources. The Society has worked with the four exam boards and with Esri UK to promote the opportunity. We recommend the Department work with DfE, and the Society and Esri UK, to join together through communications and influence to extend the reach, awareness and uptake of the free software, resources and Geomentors.

Unlocking greater value (economic, social or environmental) of geospatial data will result from new applications, innovation and creativity (as well as greater awareness and skills). Initiatives are needed to develop this innovative imagination and capacity amongst young people at schools. One productive route might be to launch a competition for apps drawing upon geospatial data (modelled loosely on the ideas of Geovation but for school students). This could work with public sector, industrial and media partners to raise the profile. This RGS-IBG would be delighted to partner on this, building on experience with initiatives such as Young Geographer of the Year – which engages 10,000s of pupils annually.

In addition, there is a need to showcase the potential and excitement around [geospatial] data and its applications to school level students whose interests will lead to careers not only in geography, but engineering, mathematics, data science, business, public health, design etc. This requires investment in a broad suite of imaginative careers profiles that can be used by teachers, career advisors (working through national networks) and directly with students too. This should actively link with STEM, social science and humanities disciplines too, and drawing on school Ambassadors programme (both Geography and STEM; RGS-IBG, 2019: https://www.rgs.org/schools/geography-ambassadors/). These should be pitched at students of all ages to fire their imagination, understand the possibilities, and recognise how expertise (or just knowledge) of geospatial data, technologies and applications can lead into successful careers, address key social, economic and environmental challenges, and benefit society. The Society has careers profiles that showcase the diversity of jobs that studying geography at GCSE, A Level and university, can lead to: RGS-IBG 2019: https://www.rgs.org/Iamageographer. The profiles include a range of individuals working across different sectors, job roles and at different stages of their careers. One sub-set of the resources highlight uses and applications of geospatial data and techniques in the workplace.

Initiatives with schools, to showcase applications and careers, are key elements of what is also needed, broader public relations activities to share success stories and raise the profile of geospatial to the public focused on themes important to them. Festivals, street-exhibitions and citizen-geography activities all could be elements of this.

Higher education

Reports (such as Geobuiz, 2018: https://geobuiz.com/geobuiz-2018-report.html) document that the UK stands out in terms of provision of geospatial training[1]. Geospatial education is increasingly being delivered in settings outside traditional realms of GIS, remote sensing and geomatics (in engineering, architecture and planning, business, public health). A fuller understanding of these courses, parts of courses, would be valuable within as well as across higher education institutions to encourage collaboration and interdisciplinary teaching. An accessible and comprehensive directory of formal provision is needed, across disciplines and institutions, to identify good practice, gaps in provision and foster new opportunities.

Based on discussions with leading university based educators, we heard expressions of interest in the development of MOOCs to bring basic geospatial understanding to new entrants and new models for interdisciplinary teaching. Forums need to be convened to bring interested parties together and catalyse development and delivery. Critically, employers/industry need to integral to these discussions from the outset to ensure the full suite of skills, knowledge and understanding is being delivered (i.e. coding (e.g. in R, Python), visualisation (e.g. Tableau, Alteryx, mapping tools) and database management, as well as core-GIS skills).

Accessing new forms of data, especially via APIs, is also a key competence that needs to be developed, as well as an appreciation of the underlying systems that generate such data. Furthermore, particularly with new opportunities (e.g. administrative data, crowd-sourced data, human-sensor etc) and heightened awareness and concerns about personal data, confidentiality and ethics, education around professional values is important for geospatial professionals.

In our interviews higher education staff, as with teachers in schools, expressed concern about having sufficient time and resource to stay abreast of state-of-the-art technical skills required in the rapidly evolving geospatial technical landscape. This needs to be highlighted as a priority and resources (time, funds, and opportunities) need to be made available for this. Short industrial or public sector placements/secondments could help in this realm. Our strategic partnership with the Association for Geographic Information (AGI) helps to provide a bridge between universities and industry.

Provision of geographical/geospatial training in further education and through technician level training is limited. A small number of geospatial mapping and science apprenticeships (level 3 and level 6) have been developed (by RICS and others to serve the needs of the surveying/geomatics professions), and other standards make reference to geospatial training, data science and cognate training. The Society is working with a small a group of employers and universities to explore opportunities for work-enhanced learning and potential for new apprenticeships, in techniques with and applications of geospatial data, which might be at entry or advanced levels.

We are keen to see geographers engage with these more and to explore the extent to which they can provide pathways for other elements of geospatial training at entry and advanced level, or if new qualifications need to be developed. These conversations need to be taken forward; key stakeholders drawn together; and barriers for uptake in universities, or further education institutions, identified and addressed.

Research and innovation

In the higher education research and innovation space, there are a number of pockets of geospatial data expertise and excellence – established and emerging. Programmes exist, through

[1] We recently updated our directory of geospatial programmes and courses in the UK, related to geography. Through this we identified 7 specialist undergraduate courses; 215 undergraduate modules; 90 Masters degree programmes; and 156 short courses.

UKRI awards, (e.g. Future Leaders) to recognise and raise the profile of expertise and innovation more widely and to foster collaborations with industry. A directory of expertise, proactive nominations for recognition (with associated media profile) would serve to raise awareness of this excellence.

More geospatial awareness and training needs to be embedded in interdisciplinary PhD training. The UKRI doctoral training centres serve as one vehicle through which to do this. Mapping of existing provision of training across ESPRC (in particular), NERC, and ESRC doctoral training centres would be a helpful first step, as would involving more industry partners and advisors in evaluating the current offer. Focused calls, or cross-centre training programmes, could then follow.

Economy

3. Objective 3. To ensure that all businesses and non-profit organisations can effectively operate in an increasingly data-driven economy

Research area: competition

3.1 Are there specific challenges that small and medium businesses or non-profit organisations face? How do these vary among different types of organisations?

3.2 How and to what extent are small and medium businesses dependent on big businesses' data and data infrastructure?

3.3 Are there interventions that government should be making to remove barriers to participation for businesses and non-profit organisations? What kinds of interventions should be made? Do these differ by sector?

Research area: technological developments

3.4 How and to what extent are small and medium businesses and non-profit organisations contributing to innovation in the data space?

3.5 Are small and medium businesses and non-profit organisations sufficiently benefiting from new emerging technologies such as AI and the Internet of Things (IoT)?

3.6 How do businesses envisage that future technological developments will change how they use data?

4 Objective 4. To improve growth and productivity through the effective use of data across the economy

Research area: productivity

4.1 How is the effective use of data driving business productivity through increased efficiency?

We encourage an inclusive as possible definition and understanding of 'geospatial' data, from 'traditional' location data, to Earth observation, to locational information (and potential) associated with administrative data, to crowd-sourced data, to data from the IoT etc. Standards, interoperability, versioning are key elements to the greater use, and value, of all of these.

Location data offer several routes to more efficient use of all data, driving greater productivity:

First, useful insights come from combining multiple types of location data, e.g. combining features of the built and natural environments, and/or location/movement of people. Geospatial data infrastructures can help to build models and forecast what is likely to happen over a period time in a given location; for example GPS data on commuting patterns can inform physical infrastructure and transport network/planning investment. We note the Gemini Principles (Centre for Digital Built Britain, 2018: https://www.cdbb.cam.ac.uk/system/files/documents/TheGeminiPrinciples.pdf) guiding the Department for Business, Energy & Industrial Strategy in the development of a national digital twin and the information management framework that will enable it. Digital twins are a valuable and effective use of location data at a range of scales.

Second, location data enrich other datasets, especially those with information about the social, economic and cultural aspects of a population or the environmental properties of an area. They are a common thread in linking multiple data sets. The FT's data visualisation editor, Alan Smith, describes spatial data as "digital glue" (FT, 2019: https://www.ft.com/content/f337e75a-b4df-11e8-bbc3-ccd7de085ffe), fusing disparate data sets into new and valuable information.

Third, location data offer a 'short-cut' to data visualisation, because they can be plotted as maps. Maps are the most well-known and familiar way for anyone to gain value and understanding from located data, presenting images of the real world that help us to navigate and understand different environments. Multiple layers of located data can be combined to produce a map, and maps can represent data at a range of scales, sometimes interconnected. Visualisation of data (moving from data to information) is essential for developing human understanding of a subject, analytical reasoning about it, and generation of new knowledge from it. The use of common standards relating to location will allow greater interoperability across datasets collated at different geographical scales, creating more accurate, efficient and insightful analysis and decision-making.

4.2 What are the barriers to the potential productivity gains from more effective data use?

We note that inconsistencies remain in the standards for collecting, storing and sharing location data, and that there is a range of public, commercial and community organisations responsible and accountable for different aspects of the UK's geospatial data infrastructure.

There are multiple organisations in the UK stewarding key data assets. The Ordnance Survey provides important national geographical information about the natural and built environment, and a number of other public bodies also collect or own geospatial data. The Geospatial Commission, as part of the Cabinet Office, has been charged with setting the UK's geospatial strategy and promoting the best use of geospatial data. Central governance and coordination of the UK's data assets, including its location data assets, creates new opportunities to open up new data and increase consistency in how data are published and licensed. We encourage the Department to work closely with the Commission to unlock the unique value embedded within geospatial data.

In terms of the barriers to productivity for geospatial data, some of the key concerns are: the fragmentation of location data (across different geographies, or reported/stored and different scales/levels of detail); lack of clarity about which organisations are responsible for collecting and publishing the data users need; the wide variety of technical platforms and formats used to publish data (not all of which are suitable for location data); the varying quality in the way data are described and tagged (geospatial data services are not well indexed by search engines); and the lack of commonly adopted standards that define common models (attributes). Private companies bridge some of these gaps.

The Open Data Institute elaborates on these challenges further (ODI, 2018: https://theodi.org/article/geospatial-data-infrastructure-report/).

We also note that the skills needed to unlock the value and productivity gains from geospatial data go beyond the noted shortage of skills for data science. Skills need to be developed not only for the creation, curation and assurance of geographic information, but also critically with the contextualisation, analysis, interpretation and use of this information. This is where geography – and its spatial lens - has a particular role to play in unlocking the value of located data, especially in relation to other datasets.

4.3 Are there best practices in particular sectors that others can learn from?

4.4 How do firms develop expertise in their use of data?

Research area: societal and environmental benefits of better data use

4.5 In what ways would better use of data provide environmental benefits around key issues such as climate change and biosecurity?

We fundamentally agree that better use of data will provide environmental benefits. Geography is the integrated study of the Earth's landscapes, peoples, places and environments. Geographers specialise in the dynamics of these phenomena, with skills based in quantitative and qualitative methods in the natural sciences, social sciences, and humanities. Geographers make sense of these data and tell stories, and are ideally placed to relate to many other fields of knowledge, which includes the increasingly complex relationship between location data/geospatial data approaches and techniques, big data analysis, and broader technological and digital advancement in the collection, use and storage of data.

We provide a set of case studies on our website that explore the ways in which geographers' use of data has informed and provided environmental benefits, including for climate change, flooding, and other key issues in the physical environment (RGS-IBG 2019: www.rgs.org/makingthecase).

4.6 In what ways would better use of data provide social and health benefits around key issues such as care of our ageing population and wellbeing?

We fundamentally agree that better use of data will provide social and health benefits. Geography is the integrated study of the Earth's landscapes, peoples, places and environments. Geographers specialise in the dynamics of these phenomena, with skills based in quantitative and qualitative methods in the natural sciences, social sciences, and humanities. Geographers tell stories with data and are ideally placed to relate to many other fields of knowledge, which includes the increasingly complex relationship between location data/geospatial data approaches and techniques, big data analysis, and broader technological and digital advancement in the collection, use and storage of data.

We provide a set of case studies on our website that explore the ways in which geographers' use of data has informed and provided health and social benefits, including for population change (ageing and mobility), migration, health and other key issues in our socio-economic environments (RGS-IBG 2019: www.rgs.org/makingthecase).

Research area: broadening data access

4.7 What kinds of data should businesses and non-profit organisations make openly available? And why?

4.8 Should government encourage businesses and non-profit organisations to make more of the data they hold open? If so, how?

We support the principles of open access and stress the importance of making access to data sustainable, inclusive and equitable. We recognise that creating an infrastructure of open data

sustainable will require significant further investment, as tools for data collection, curation, storage and sharing are not without cost. We suggest that the implementation of 'open-ness' could be made on a sliding scale, with those datasets which offer the greatest collective benefit be prioritised.

We note that alongside the discussions around open data, there is research on the creation and use of data trusts (ODI, 2019: https://theodi.org/article/huge-appetite-for-data-trusts-according-to-new-odi-research/) and other forms of secure data sharing. We consider the principles of data quality, security and trust to be important, and note that data is more commonly shared between trusted partners.

4.9 Where appropriate, how might government encourage businesses and non-profit organisations to share more data they hold, where it cannot be made open?

We encourage further discussion of how businesses and other organisations might share data, especially where those organisations procure, transform and gain value from open data without subsequent re-sharing of data or transformation process, or broader transparency regarding their compliance with the principles of open licenses.

As a non-profit organisation we are alert to the costs and burdens of stewarding and sharing data sets. Encouraging organisations to share data requires recognition that the costs involved with sharing (e.g. the technical and ethical skills and knowledge to adequately and appropriately anonymise datasets for release, especially those containing location data) should be proportionate to the expected benefits gained by sharing the data.

Research area: growth and efficiency underpinned by public sector data

4.10 What is the best approach to valuing public sector data in order to reflect its potential to stimulate private sector growth and to offer wider public benefits (financial or non-financial)?

4.11 How can the public sector quantify, evaluate and weight these benefits in order to determine the terms on which the data could be made available?

There are very special opportunities afforded within government, and beyond, through the work of the new Government Geography profession in Government Science and Engineering (GSE, 2018: https://governmentscienceandengineering.blog.gov.uk/tag/geography/). The profession transcends central, local government, crown bodies and others.

The Head of the profession, David Wood, and the eleven deputy heads have been charged with responsibilities across the development of geospatial training, standards, the sharing of good practice in embedding geography into policy development and delivery, and accreditation of expertise for those involved using geographical data and approaches within government.

Members of the profession are particularly well placed to identify synergies and capitalise on opportunities with allied professions (e.g. the digital, data and technology profession) and in embedding good geospatial practice in the frameworks and competencies of other professions (economics, social research, statistics as examples). Many members of the profession already act (sometimes informally) as geospatial data champions within their respective organisations.

International comparisons

4.12 Are there robust international comparison measures of how data is driving economic growth, productivity, and innovation? Which are the most effective?

Government

5 Objective 5. To improve public services and government operations through the effective collection, sharing and use of data

Research area: current use of data

5.1 How effectively are government and the wider public sector collecting, sharing, analysing and storing the data it holds? What does good practice look like? What does bad practice look like?

The Government Geography profession has highlighted good practice using geographical information and spatial data in the first year of its Geography in Government Awards (GSE, 2019: https://governmentscienceandengineering.blog.gov.uk/2019/04/05/geography-in-government-awards-shortlisted-nominations/ and RGS-IBG, 2019: https://www.rgs.org/professionals/geographers-in-government-awards/)

The DfID Grid3 project was recently identified by the Office for AI as an example of good practice in government use of artificial intelligence for social benefit (Office for AI, 2019: https://www.gov.uk/government/case-studies/how-dfid-used-satellite-images-to-estimate-populations; DfID, 2019: http://grid3.org/). It uses a machine learning algorithm to analyse satellite images and micro-census data to help developing countries better understand their population distribution based on observed infrastructural features.

We encourage the Department to actively engage with the Gemini Principles (Centre for Digital Built Britain, 2018: https://www.cdbb.cam.ac.uk/system/files/documents/TheGeminiPrinciples.pdf) which are guiding the Department for Business, Energy & Industrial Strategy in the development of a national digital twin and the information management framework that will enable it. Digital twins are a highly valuable and effective use of location data at a range of scales.

5.2 What are the main barriers to more effective data use within government? Are there barriers in cases where government works with the private sector?

5.3 Are there areas within data management, use and access where there is a skills gap in government? What additional data skills are needed in government?

5.4 How effectively are local authorities using the data they hold? What challenges do they face?

We provide a set of case studies on our website that explore the ways in which use of data has informed and provided benefits for both physical and socio-economic environments, including within local authorities (RGS-IBG 2019: www.rgs.org/makingthecase).

The Government Geography profession has highlighted good practice in local authorities using geographical information and spatial data in the first year of its Geography in Government Awards (GSE, 2019: https://governmentscienceandengineering.blog.gov.uk/2019/04/05/geography-in-government-awards-shortlisted-nominations/ and RGS-IBG, 2019: https://www.rgs.org/professionals/geographers-in-government-awards/)

GeoPlace have assembled case studies in local authorities' use of location data: https://www.geoplace.co.uk/helpdesk/library/case-studies

We hosted a meeting in early 2019 on work by geographers towards the Sustainable Development Goals, which highlighted the many cross-cutting ways in which local authorities and others are collecting, using and analysing location data. We would be delighted to work with the Department

and the Government Geography profession to further explore the challenges of obtaining, using, or gaining insight from geospatial data within local authorities around particular themes or issues.

5.5 How effectively are wider public sector organisations using the data they hold? What challenges do they face?

We provide a set of case studies on our website that explore the ways in which use of data has informed and provided benefits for both physical and socio-economic environments, including within the wider public sector (RGS-IBG 2019: www.rgs.org/makingthecase).

The Government Geography profession has highlighted good practice in public sector use of geographical information and spatial data in the first year of its Geography in Government Awards (GSE, 2019: https://governmentscienceandengineering.blog.gov.uk/2019/04/05/geography-in-government-awards-shortlisted-nominations/ and RGS-IBG, 2019: https://www.rgs.org/professionals/geographers-in-government-awards/)

We hosted a meeting in early 2019 on work by geographers towards the Sustainable Development Goals, which highlighted the many cross-cutting ways in which the public and private sector are collecting, using and analysing location data towards achieving the goals. We would be delighted to work with the Department and the Government Geography profession to further explore the challenges of obtaining, using, or gaining insight from geospatial data within the public sector around particular themes or issues.

Research area: improving data use

5.6 What can government and the wider public sector do to improve its collection, sharing, analysis and storage of data?

5.7 How can the government create incentives for these improvements?

5.8 Are there areas within data management, use and access where there is a skills gap in government? What additional data skills are needed in government?

The recent National Audit Office on *Challenges in using data across government* highlighted that many datasets are disparate, and that location data could be a key way to link them. The report highlighted plans to use UPRN (Unique Property Reference Number) as one possible linking field across central/local government datasets. The report also noted that considerable time and cost is incurred in data cleansing, or in mitigating the impact of a lack of, or inadequate quality, data, which can cause major errors (National Audit Office, 2019: https://www.nao.org.uk/report/challenges-in-using-data-across-government/). We encourage the Department to consider the role of geospatial data in providing the 'common thread' between disparate data sets and the associated skills required and refer to our answers to Questions 2.7, 4.1, 4.2 and 4.11, above.

5.9 What private sector practices in data management and governance can the public sector learn from?

5.10 What are the main opportunities for improving outward facing public services through effective data use?

6 Objective 6. To achieve alignment in government around data, with data shared and used cooperatively wherever appropriate

Research area: barriers to data sharing within government

6.1 When should public authorities open up access to data they hold with other departments? When should they not?

6.2 When do people find that government has improved services through better use of data? In which areas would people most like to see data better used?

6.3 What issues are there around government increasing access to the data it holds between departments and other parts of the public sector? Does the use of Privacy Enhancing Technologies sufficiently counter any such risks?

6.4 What kinds of problems do barriers to data sharing create for government departments and public sector organisations?