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KTN

Meeting Net Zero with the Power of Place

Where location intelligence meets the fight against climate change

Foreword

Big societal and environmental challenges such as climate change, health and the future of agriculture require powerful solutions.

This report, *Meeting Net Zero with the Power of Place,* describes how location intelligence can be used as a powerful solution to so many of our societal and environmental challenges.

Meeting Net Zero with the Power of Place also highlights the need to accelerate the pace of innovation, maintaining and building on the global momentum for change seen throughout the pandemic.

Innovate UK's Plan for Action outlines how we will drive productivity and economic growth by supporting ambitious businesses to develop and realise the potential of new ideas. Working collaboratively, we will develop new ways of thinking: building from incremental innovation to mission-oriented and transformative systems-based approaches.

Our Space & Geospatial Virtual Pavilion hosted at COP26 and the supporting podcast series are examples of how Innovate UK works to inspire future innovators, involve key partners and invest in people and technologies. Through creating these opportunities that are visible and compelling to talented people and organisations, we will accelerate system change and provide greater positive impact on our future economy and society.

Please consider the ideas presented in this report and, if you wish to contribute or get involved in any way, our Innovate UK KTN team would be pleased to help you play a part to influence and shape our shared future.

Indro Mukerjee
CEO
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Preface

In November 2021, representatives from all UN members states, members of civil society, NGOs and academia convened in Glasgow for the 26th edition of the United Nations Climate Change Conference (COP26). The event sought to discuss and negotiate the best way to achieve four goals:

1. Secure Net Zero by mid-century
2. Adapt to protect communities and natural habitats
3. Mobilise the finance necessary to transition to a low-carbon economy
4. Tackle the climate crisis through collaboration

Hosted by Innovate UK KTN and curated by more than thirty partners (see page 43-45), the Space and Geospatial Virtual Pavilion for COP26 sought to demonstrate the key role geospatial data and enabling technologies play in delivering against these goals.

This report builds on the discussions that took place during the Virtual Pavilion and highlights the key areas of interaction between the geospatial ecosystem and the fight against climate change. The paper will explore why shifting our siloed approach on sector-based solutions towards a holistic system approach is key to understanding feedback across systems. We will also introduce the role of innovation in building a resilient, value-based economic system and delve into why we need to do this by working together.

For a topic as all-encompassing as climate change, there is no silver bullet that can stop its effects. A collective effort is required from the widest range of industries, political authorities, and scientific enterprises, one which sees open sharing of data and approaches for the greatest common good: the protection of our planet.

In support of this effort, the chapters will explore the challenges and opportunities within a set of critical sectors, including transport, built environment, nature, finance and energy; through this, we wish to support decision-makers, industry, and civil society understand that geospatial intelligence is key business intelligence that can help them build a more resilient and prosperous tomorrow.

This publication is available in two formats: a digital version where the reader can delve into an in-depth exploration of geospatial and climate topics, and a shorter, interactive version featuring case studies and video extracts from the Virtual Pavilion. If you would like to digest content on the move, we warmly recommend tuning in for the 'Geo for Earth' podcast series that accompanies the publication.

Acknowledgements

We would like to thank the many people who over the past year have contributed their time in supporting our efforts to demonstrate the value of space data and geospatial intelligence in tackling climate change. These people have helped create the pavilion sessions, provided expert knowledge and supported the writing and reviewing of each and every chapter. Without their efforts, none of this would have been possible.

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Finally, we like to thank the organisations that have offered their time to review the content of this publication and provided helpful feedback. The Geospatial Commission, Spatial Finance Initiative, Group on Earth Observations, Space4Climate, TravelAI and AGI for authoring the "Built Environment and Cities" chapter.

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How the power of place can protect our planet

Geospatial intelligence is critical to understanding our planet and solving the challenge of climate change. To influence changes at the global level, we need to understand the impact of climate change at the local level. Collecting data at the local level uniformly and consistently, however, has historically proven difficult due to disparities in capabilities, resources, and willpower across different regions.

This is beginning to change, as wider recognition of the urgency of the climate crisis takes hold and data collection methods become more available and affordable globally. With increased amounts of data, as well as more types collected from locations where knowledge was previously limited or altogether missing, the greater the overall picture of the state our planet becomes.

The picture it shows is one of siloed knowledge, where stakeholders remain competitive, rather than collaborative, and therefore effective advancements in the fight against climate change are too often stymied. To alter this picture will require much wider sharing of data and intelligence so that the systems in which humans operate, whether transport, energy, or finance, for example, can be improved as a whole, and not simply according to the need to appease specific shareholders. There is immense opportunity for inclusive growth and cultural change if geospatial data is harnessed correctly and shared widely.

The hope, then, is that environmental monitoring becomes more democratised, as more developed nations increase access to technologies and finance for developing countries. Not only will this serve to fill in the gaps in our knowledge sooner but will also likely highlight previously unknown issues and effects of climate change that need remediation.

To realise such ambitions necessarily requires collaboration. Without developed nations providing financial and technological assistance more freely, there is little chance for effective engagement with local, developing regions. However, money isn't a cure-all, as facing down climate change will require clarity in leadership.

The Earth's changing climate is an extremely complex equation, in which there are few, if any, fixed parts. It is a non-linear issue, from which we don't always understand the downstream impacts, and its effects cascade into all realms of life – from political and economic, to social and cultural. It therefore requires a 'portfolio mindset', that is, a wide reach and spread of activities that tackle the huge number of climate change issues effectively and simultaneously. This requires location data - in quantity, of sufficient quality, and sustained accessibility. As former US Vice-President Al Gore said in his address to the Pavilion, businesses and governments need to be armed with this information to enable real action.

As will be shown throughout this report, the future of the fight against climate change will be defined not by competition, but by how well different parties collaborate, share, and ultimately thrive.

> Location data is the link identifier connecting the dots between the infrastructure we use every day (objects), our communities (people), transport, energy, healthcare (systems), and the natural habitat that supports our wellbeing (environment).
>
> **Luca Budello**
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> **Net Zero** is a complex challenge requiring input from multiple sectors. Between these diverse concerns, location may be the only unifying factor.
>
> **Elspeth McIntyre**
> **Senior Geospatial Consultant**
> **Atkins**

Summary of key terms

Adaptation: The alterations made to behaviour in response to, and in order to accommodate specific environmental circumstances. Often required simply for survival.

Carbon footprint – The total greenhouse gas emissions caused by an individual, event, organisation, service, place, or product, expressed as 'carbon dioxide equivalent' (CO_2e), as emissions are not limited to carbon dioxide alone.

Clean energy – Energy originating from sources that are renewable, zero-emission, and which do not pollute the atmosphere when used. While all clean energy is renewable, not all renewable energy is clean. For example, some hydroelectric energy sources can damage natural habits and cause deforestation.

Climate change – The long-term shifts in temperatures and weather patterns. They may be natural, through variations in the solar cycle, for example, but are also increasingly driven by human activities - primarily the burning fossil fuels such as coal, oil, and gas, which emits greenhouse gases.

COP26 – Short for 'Conference of the Parties', COP26 was the 26th United Nations Climate Change conference held in Glasgow in 2021. It brought nations together to accelerate actions towards the goals of the Paris Agreement and the UN Framework Convention on Climate Change.

Decarbonisation – The reduction of carbon dioxide emissions through increasing the use of low- or zero-carbon power sources and reducing the use of fossil fuels.

Environmental, social, and corporate governance (ESG): ESG is an approach for assessing how a company operates beyond its responsibility of maximising its profits on behalf of its shareholders. It includes sustainability goals, and goals around diversity, equity, and inclusion.

Geospatial data – Geospatial data, is the record of what we do, and where we do it. It tells us where people and objects are in relation to a particular geographic location, whether in the air, on the ground, at sea or under our feet.[1] (Also known as 'location data', though 'geospatial data' will be used predominantly in this report.)

Geospatial intelligence – The insight gleaned on specific locations through the analysis of geospatial and ancillary data, often achieved with Artificial Intelligence. It enhances understanding of locales and can enable more targeted decision-making and predictions. (Also known as 'location intelligence', though 'geospatial intelligence' will be used predominantly in this report.)

Global warming – The long-term heating of Earth's climate, observed since the pre-industrial period (1850-1900). It is the result of human activity, primarily the burning of fossil fuels which releases heat-trapping greenhouse gases into the Earth's atmosphere.

Innovation – The means by which solutions to the challenges posed by climate change are found. Can be thought of as on a sliding scale from incremental innovation, where small improvements are made to existing systems and solutions, through to radical innovation, where solutions provide an entirely new answer to a challenge. Motives for innovation are equally wide-ranging, from profit-led to mission-led for example.

Paris Agreement – An international treaty on climate change, adopted by 196 nations in 2015. It seeks to limit global warming to well below 2 degrees Celsius (but preferably 1.5) compared to pre-industrial levels. To achieve this goal, countries aim to reach the global peak of greenhouse gas emissions as soon as possible and achieve a climate-neutral world by mid-century.

Renewable energy – Energy originating from sources and processes that are constantly replenished, including solar, wind, and hydroelectric.

Resilience – Creating systems and infrastructure capable of withstanding shocks and changes before they occur, rather than after the fact.

Space data – A subset of geospatial data, space data is any type of data that directly or indirectly references a specific geographical area or location and is collected via assets in space, most frequently satellites. Given its nature, it is often referred to as Earth Observation data or EO data.

Sustainability – Defined by the 1987 Brundtland Commission report for the UN as 'meeting the needs of the present without compromising the ability of future generations to meet their own needs.'[2] In an environmental context, this means not overusing resources or degrading habitats.

1 'Unlocking the power of Location: The UK's Geospatial Strategy, 2020-2025'
2 Report of the World Commission on Environment and Development: Our Common Future, 1987.

Connecting for
Positive Change.

Innovation

- The current model of innovation
- Building the Innovation economy
- Creating system value
- Achieving system value through data

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The current model of innovation

While there is wider recognition of climate change, as well as more initiatives designed to counter global warming than ever before, the world is not on track to limit global warming to a 1.5-degree temperature increase as set out in the Paris Agreement.[3] New ways of looking at the challenges ahead are needed then to drive the innovation that will limit global warming.

Innovation can take many different forms. It can be driven by the development of new products derived from the R&D in new technologies (technology push), or it can be driven by the need of the market where a product or service is designed to meet those needs (market pull). Often it is the result of both processes happening in sequence where the availability of a new technology creates the demand for new products or services.

In the context of solving the many challenges we face in society; innovation cannot be deployed in a business-as-usual scenario. Building a product that is slightly better than the competition or a service that uniquely serves an economic outcome is not going to create value to the wider society. The scale of the challenges we face and the ramifications of the consequences for bad choices require innovation that is mission-led; and this needs a new mindset to deliver innovative solutions that is user-centric, collaborative, deal with complexity, deliver outcomes that create system value, and is delivered at pace.

The economist Milton Friedman in a famous New York Times article said that a business's sole purpose is to generate profits for their shareholders, and companies that pursued other missions would be less competitive. Friedman's 'shareholder theory', or 'shareholder value' puts creating profits at the expense of all else, including the environment, and is therefore an unsustainable business approach for a planet with finite resources and a rapidly increasing population.

An improved approach was espoused in the Harvard Business Review, termed 'shared value', whereby companies and institutions continue to focus on financial performance, but are more mindful of 'doing the right thing' towards society and the environment in their practices. Where this approach struggles is in its limited ambition, as it is desirable to interlink benefits for the business, society, and environment, but if unachievable, profits once again take centre stage. It also struggles in its ambivalence towards the negative effects of business – that is, while one activity might appear to solve one societal or environmental problem, it may simply be shifting it elsewhere.

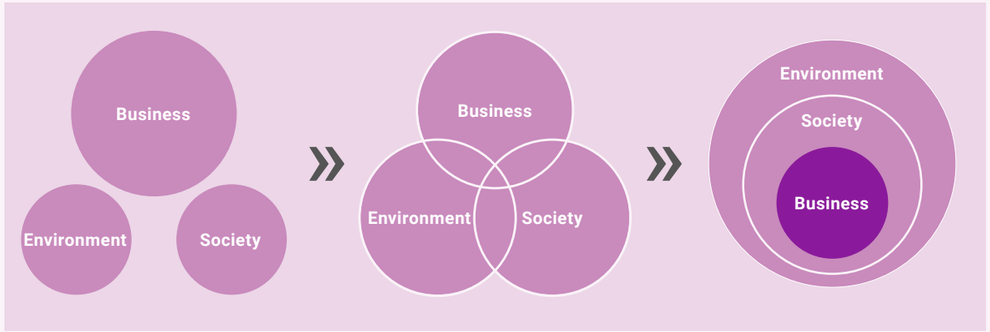
3 Climate Action Tracker, 'Evaluating progress towards the Paris Agreement.'

Building the innovation economy

Innovation economics is a field of economic theory that emphasises entrepreneurship and innovation as the main tenet on which economic growth is built. In innovation economics the primary drive of economic growth is not capital accumulation as it is for neoclassical economics, but innovative capacity encouraged by appropriable knowledge and technological know-how. Innovation is therefore the main driver of growth.[4]

Both innovation economics and neoclassical economics advocate for economic growth but the main difference is the context in which they operate. In a neoclassical economy, businesses behave in a vacuum; and innovation serves the purpose of staying ahead of the competition to generate profits. Whereas in the innovation economy, businesses have a purpose beyond simply generating financial wealth. In this case, innovation is also a driver of solving social and environmental challenges.

Economists such as Kate Raworth and Mariana Mazzucato are proponents of innovation that is mission-led and they assert that the main goal of business should be to deliver 'smart', inclusive, and sustainable growth. Raworth's and Mazzucato's approaches are both ways of thinking about innovation economics and how this can be linked to deal with the complexity of the 21st century challenges to create 'system value'.



Shareholder Value
Financial returns are all that matters: companies privatize gains and externalise losses

Shared Value
Business comes first: negative impacts are often not sufficiently internalised, or are justified by 'doing good' elsewhere

System Value
Business addresses societal needs in a holistic way, while not hindering progress toward a flourishing future

Figure 1. Future-Fit Business Benchmark (2015), Copyright Future-Fit Foundation

4 Phil McKinney, 'Understanding the Innovation Economy and Its Impact on Our World.'

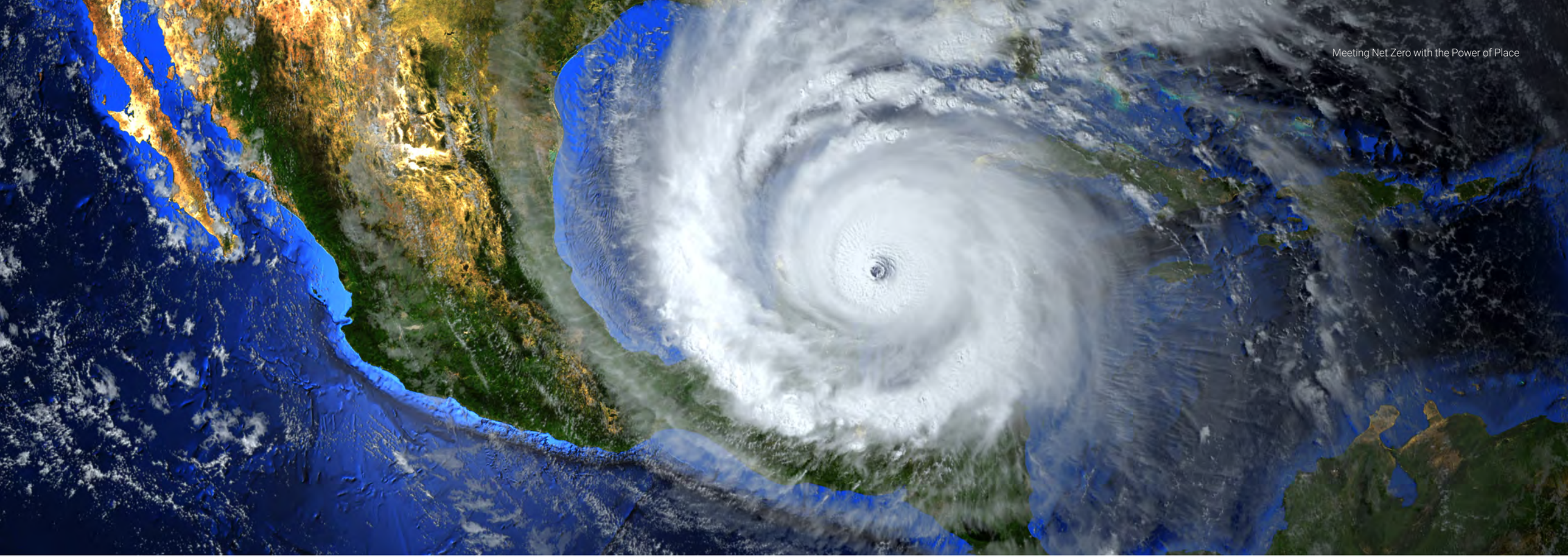
Creating system value

While no organisational decision can ever fully avoid potential trade-offs, they can be much better foreseen, and thus mitigated or avoided, by ensuring a systems-based approach is taken. A systems-based approach is in essence a holistic approach to decision-making, whereby all interrelated and interdependent parts re considered so as to allow the greatest positive outcome for business, society, and the environment. Innovation has a direction as well as a rate,[5] and by shifting towards 'system value', the direction of innovation is to the benefit of everyone.

This is no doubt a step change in the mindset of the majority of organisations and the way in which they conduct themselves and take operational decisions. However, it is only through such a change that mission-led innovation will occur. And it is this kind of innovation that is ultimately required, for mission-led innovators will look at the multifaceted challenges posed by climate change and help create a portfolio of innovative activities to solve them, and which help build public value and tackle societal challenges.

Mission-led innovators will look at the multifaceted challenges posed by climate change and help create a portfolio of innovative activities to solve them, and which help build public value and tackle societal challenges.

5 Mariana Mazzucato, 'Mission-Oriented Innovation Policy: Challenges and opportunities,' 2017.



Creating system value is a radical approach and therefore requires a framework for organisations to adopt such thinking. One such framework suggested is that of 'the doughnut', or 'doughnut economics', defined by Kate Raworth – co-founder of Doughnut Economics Action Lab and Senior Associate at Oxford University's Environmental Change Institute.

Raworth's 'Doughnut' presents a visual framework that combines the concept of planetary boundaries (that is, ecological ceilings upon which life depends and which must not be overshot), with social foundations (that is, the elements which constitute a fair and functioning society). According to Raworth, an economy can be considered prosperous when all the twelve social foundations are met without overshooting any of the nine ecological ceilings. Important to note, that 'prosperous' in this definition does not mean that an economy is monetarily sound, but instead, all who operate within an economy have their needs met to an acceptable standard, without unduly affecting the natural environment.

Setting clear high and low boundaries in this way gives organisations and innovators the impetus to work smarter to meet such restrictions, and not in a wasteful, harmful way simply to increase profits. Not only is the 'Doughnut's' 'safe and just space for humanity' more than wide enough to spur innovation capacity, through having fixed 'red lines', it sets out the terms of engagement clearly for all those seeking to innovate and create solutions that will bring positive effect to the fight against climate change.

Another example of creating system value is Mission-Oriented Innovation, developed by Mariana Mazzucato - Professor in the Economics of Innovation & Public Value at University College London (UCL), where she is the Director of the Institute for Innovation and Public Purpose. Mazzucato's approach focuses on sustainable, inclusive growth, as well as how value is created in the current economic system. She draws inspiration from the 1961 challenge to take an American to the moon, the first 'moonshot', and argues that government and civil society should be directing our efforts today to equally substantial challenges.

Mazzucato's operational framework looks at the role of innovation in co-creating markets in a way that is collaborative, welcomes uncertainty and it is transformative. Part of this relies not only on active government investment, but also the active engagement of a wider stakeholders' pool to define what is public value and how it can be achieved.

In practical terms, 'Grand Challenges' such as the 17 UN Sustainable Development Goals must be split into smaller, individually achievable, pragmatic steps that use the collective intelligence of the wider stakeholder pool to understand their public value. In doing so, it will then be possible to create a portfolio of innovation projects that are truly cross-sectorial and that tackle the complexity of the challenges meaningfully.

As has been stated, it is safer for organisations to stick to tried and tested methods that simply seek to yield increased profits. Yet this 'safety' is purely in the short-term. By focussing on 'shareholder' or even 'shared' value, the end result is the same: the environmental impact is too great for the planet to cope, and ultimately unsustainable. A systems-based approach, informed by either Raworth's 'Doughnut' model or Mazzucato's Mission-Oriented Innovation, is achievable, and can in fact offer much greater resilience for businesses, society, and the environment alike through its ability to generate innovation capacity.

Achieving system value through data

Central to enabling innovation capacity and adopting a systems-based approach is the shifting of data from a coveted commodity to a shared resource. To this end, the 'FAIR Guiding Principles for scientific data management and stewardship' were published in 2016 in an attempt to establish the groundwork for much more open knowledge sharing in the age of big data.

The **FAIR Guiding Principles** assert that data should be:[6]

- **Findable**: Metadata and data should be easy to find for both humans and computers. Machine-readable metadata are essential for the automatic discovery of datasets and services.
- **Accessible**: Once a user finds the required data, they need to know how it can be accessed, including any authentication and authorisation.
- **Interoperable**: Data rarely exists in perfect isolation, so it should be interoperable with multiple applications or workflows for required analysis, storage, and processing.
- **Reusable**: Ultimately, FAIR seeks to optimise the reuse of data. It is in this way it can serve the maximum number of people and settings. Data thus needs to be well-described so it can be replicated and/or combined with other data.

Already there are numerous success stories of the power of systems-based data sharing in the way described by the FAIR Principles. Notable examples include the likes of Airbnb, Uber, and countless parcel tracking services. Each have combined mobile app technology with business models that create user-providers of data in order to develop continually updated and improving services.

What is required in the face of climate change, specifically, is much broader sharing of geospatial data. This means going beyond simple data sharing to enable smart enterprises and instead creating value for entire regions and ecosystems. Geospatial information represents much more than the 'digital map' of a nation; it is the 'digital currency' for evidence-based decision-making. Therefore, to provide stakeholders and end-users with findable, accessible, interoperable, and reusable geospatial data it is crucial to establish an ecosystem where all can cooperate so as to make the crucial decisions when they are needed, rather than when it is too late.

Efforts towards this goal are being made by the likes of the Integrated Geospatial Information Framework (IGIF). This is a product from United Nations Global Geospatial Information Management (UN-GGIM), itself a department of the United Nations Statistics Division. Serving as an intergovernmental blueprint, it comprises overarching strategy, implementation guidance, and action plans at the country level, independent of any national spatial data infrastructures. The IGIF was created to equip countries, with limited geospatial data capabilities, with a basis and guide for developing, integrating, strengthening, and maximising geospatial information management and related resources. With emphasis on understanding capacity and capability shortcomings, the IGIF helps build the resilience in geospatial data collection and sharing that is required to grow much greater innovation capacity in developing nations.

Comprising local and global strategies, implementation guidance, and action plans at a national level, the IGIF seeks also to catalyse economic growth in developing countries, stimulate better understanding around geospatial data and its uses, combat climate change, and enable global collaboration and data sharing. It is evidence of creating system value on a national scale, and therefore illustrates the benefits not only to other nations, but also private enterprises, of shifting from siloed intellectual property and competition to a collaborative model based on data sharing.

Case Study:
Making insight from geospatial data more accessible

Billed as a 'no-code' software-as-a-service (SaaS), Earth Blox enables users to extract meaningful insights and intelligence from geospatial data, without any coding knowledge or expertise. Dragging and dropping datasets allows for quick comparison, along with custom build workflows that are accessible wherever the user is based. In this way, users can rapidly quantify the risk or damage from recent and historical disasters, as well as identify issues ahead of time to create sustainable supply chains or detect places and people most at risk. With petabytes of accessible data stripped of analysis complexity, it greatly helps democratise geospatial data.

Integrated Geospatial Information Framework

How do we implement geospatial thinking and capability? The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) has put in place a framework to enable an approach to developing geospatial capability.

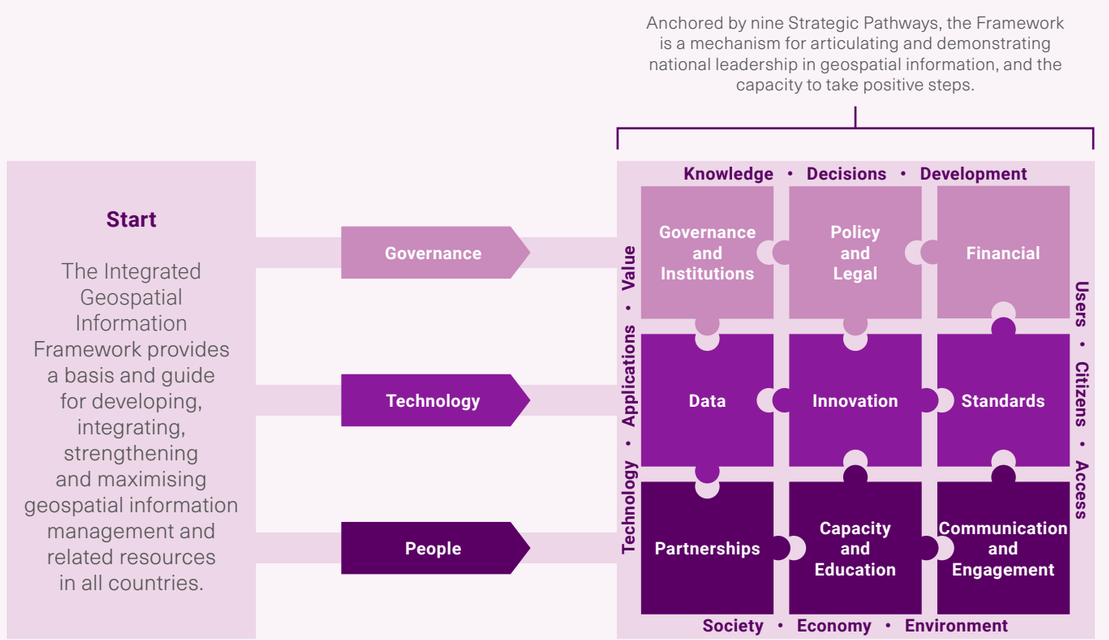


Figure 2. Integrated Geospatial Information Framework

6 Go Fair, 'FAIR Principles'

For example, in Mongolia, it is calculated that geospatial data can contribute to:

1. A reduction in 1,896 million tons of CO_2
2. A saving of $2.6 million when used in planning decisions
3. A saving of $33.2 million when responding to disasters
4. The creation of $6.2 million for new jobs in geospatial data
5. The planting of 1 million more trees
6. The saving of $18.3 million for reduced survey costs in the likes of mining[7]

7 Agency for Land Administration and Management, Geodesy and Cartography, 'Geo-driven Digital Transformation and Innovation in Mongolia.' - (31:00)

The IGIF also works towards achieving the UN's 17 Sustainable Development Goals (SDGs) which seek to end poverty and other deprivations, improve health and education, reduce inequality, and spur economic growth, while also tackling climate change.

Another organisation seeking to improve access to geospatial data is the Open Geospatial Consortium (OGC). It connects, people, communities, and technology in order that they may collaborate more easily and effectively in solving global problems. Currently representing over 500 businesses, government agencies, research organisations, and universities, it creates free, publicly available geospatial standards to ensure the widest adoption and application of the FAIR principles.
With initiatives such as IGIF and OGC working towards open data sharing and collaboration, there is greater chance of businesses, and indeed, nations, adopting systems-based approaches to decision making and thus innovation. This will in turn create an altered global mindset, one where building collaborations can generate value for businesses, society, and the environment equally. With such data resilience serving as the foundation upon which all can rely, there will therefore be increased opportunity for the kind of mission-led innovation required to truly address and combat climate change; innovation that, until this point, has had limited exploitation and scale up.

Case Study:
Creating FAIR climate services

OURANOS is looking to apply the philosophy of the FAIR principles into climate services as well as for data, to enable the climate science community to provide these services effectively in response to climate change. Climate services take historical observations and future projections and turn them into actionable information for audiences such as engineers and infrastructure planners. It is hoped that this heightened understanding of the climate services process can support enhanced innovation capacity and the adoption of a comprehensive systems-based approach.

Connecting for
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Finance

- Spatial finance in support of climate action
- The breadth of financial opportunity for geospatial data

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Spatial finance in support of climate action

The importance of finance in averting climate catastrophe is irrefutable. The correct allocation of finance will establish and support activities that will make the difference in the fight against global warming, and disincentivise activities that exacerbate the issue.

The financial sector is already waking up to this responsibility. By the end of 2019, over 2,300 investors representing USD $86 trillion under management had signed up to the UN Principles of Responsible Investment, 450 investors with USD $40 trillion in asset under management had signed up to the more ambitious Climate Action 100+ scheme and over 1,000 organisations worldwide, representing a market capitalisation of over $12 trillion, had expressed support for the Taskforce on Climate Related Financial Disclosures (TCFD).

In determining what roles finance can play in fighting climate change, the discussion on shareholder and shared value versus system value in creating wide-ranging, mission-led innovation is of use once again.

A shared value approach recognises the need for businesses to de-risk their assets and supply chains. This can mean either climate transition risk (the risks of a changing policy or technology landscape, as climate action accelerates and more polluting activities are likely to be penalised), or physical climate risk (physical changes in our climate/weather patterns impacting business operations or supply chains). This is the most common framework to refer to climate risk, and geospatial data and tools can help to better understand both.

However, as was discussed with regard to innovation, this is not a comprehensive solution. While undoubtedly having positive effects, only de-risking certain features can still create unanticipated negative impacts elsewhere which can potentially be dismissed as simply the 'cost of doing business'. The aim, therefore, must be to overhaul the understanding of the potential for finance in the fight against climate change.

Realising this potential will require a more fully developed understanding of businesses' climate impact at every stage of their value chain, as well as greater ability to invest in sustainable, climate positive activities. In each case, trust and reassurance will be the key factors in moving financial institutions and businesses towards greener investment. Without compelling data of the integrity of green financial initiatives, there is reduced chance of widespread uptake and investment.

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Case Study:
Detecting credit risk through climate risk

Nationwide Building society has developed a climate change risk standard to aid the embedding, management, and monitoring of climate change risk as a cause to the society's most significant risks. The standard articulates how climate change risk may occur across society's Enterprise Risk Management Framework (ERMF), and links to its principal risk policies. As part of developing the standard, Nationwide identified a gap in how and when data was being collected on a mortgaged property. It found that consideration of environmental risks to properties often only took place after mortgage offers had been issued, leaving the society much more greatly exposed. To address this, Nationwide and its partners including Airbus Defence and Space, JBA and Ordnance Survey, developed the Property Risk Hub.

The Hub collects data on properties and their locales in order to better support future decision making and manage climate risk. Of greatest interest is the collected geospatial data, including Energy Performance Certificate (EPC) rating, flood, coastal erosion, and ground stability data, along with natural ground hazards. In collecting and analysing this data, Nationwide can use it to assess the risk for lending certain properties pose through potentially changing climate and environmental factors over a typical 25-40 year mortgage term. As a mutual financial institution, geospatial data therefore protects not only the commercial interests of the society as a whole, but those of existing members, and also of those seeking to obtain a mortgage from the society. It is, after all, in no-one's interest to invest in a property liable to be significantly impacted by existing or potential environmental factors. What's more, if the data is shared, Nationwide hold an invaluable resource for other actors in the fight against climate change.

The first step to financing the fight against climate change is to understand which factors drive financial firms' thinking around risk management, and how to alter these.
Currently, there are three key drivers:

1 **Operational Risk:** Business operations can both have an impact on (and contribute to) climate change and be impacted by the effects of climate change themselves. Thus, firms are seeking to invest in methods of preventing or avoiding such impacts, whether through direct action to safeguard a geographical location, or relocating activities altogether from an area. The more resilient a firm's supply chain, for example, the less volatility their business will experience, and the lesser negative impacts it will generate.

2 **Compliance with Regulation:** Falling foul of regulatory measures, whether industrial or governmental, necessarily poses a risk to businesses, often financial, but also reputational. With clear, mandatory requirements placed on business around developing green working practices, such as climate risk reporting, it is intended that firms will be incentivised towards greener, more sustainable activities, and away from riskier, specifically non-green, industries.

3 **Reputational Risk:** Further to the potential harm non-compliance of regulations can do to a firm's reputation, businesses are also noticing a generational shift in attitude from customers towards their money. For many younger persons, ease of goods and monetary returns are not the sole consideration when choosing a business to purchase from or invest in; they would prefer to know that that business acts in a way that is sustainable for the planet and directed towards green activities.

There is clearly cause for financial institutions and businesses to want to invest 'greener', and engage in more sustainable practices, but how can those that seek to minimise risk be sure that their investments make a positive impact on the environment while still generating the financial returns they want to see?

Finance, more specifically, the unlocking of capital for investment in greener activities and decision-making, relies above all else on confidence. The answer to instilling this confidence also lies in geospatial data.

Case Study:
Better understanding climate risk in vulnerable regions

Mantle Labs is using its geospatial technology platform Geobotanics to inform agricultural credit lending decisions. The software can be used to analyse crop loss index, drought likelihood, predict yields and monitor crop density. This helps Mantle Labs establish a credit profile for individual farms, providing a more complete risk assessment for banks and insurers. This reduces the risk to financial institutions when providing debt finance or insurance products to smallholders in developing countries. Geospatial data is therefore harnessed to create new markets for the financial service industry, while simultaneously increasing access to finance for those previously un-banked. Improving the confidence of investors and insurers in this way is paramount to providing wealth to under-developed nations and maintaining stable and sustainable food supply networks.

The breadth of financial opportunity for geospatial data

The key feature geospatial data affords financial considerations is improved visibility, providing an independent, transparent, verifiable, and robust measure of climate change. Earth observation data, the likes of satellites, radars, and even atmospheric gas detectors, has enabled remote or previously inaccessible regions to now be readily available for viewing from anywhere on the globe.

This visibility provides the opportunity for much greater bottom-up analysis of a region's climate, nature, social nuances, and more, and thus insight into the sustainability and overall impact of business activities from the physical asset upwards. Every facet of a supply chain is now available for scrutiny from a conscientious producer of goods for example, leaving little space for non-compliance with green initiatives, so long as the necessary regulations exist.

Geospatial data also provides the requisite insight for financial products themselves. Consider the better risk assessment available for insurers looking at the likelihood of flooding within a certain area; the ability of a commodity trader to improve forecasting for the futures market thanks to knowledge of optimal crop regions; the reassurance available to an investment bank doing due diligence on a company that purports to utilise only slavery-free or deforestation-free supply chains.

Visibility, bottom-up analysis, and subsequent insight afforded by geospatial data thus gives the granularity necessary to assess risks, impacts, and opportunities more accurately, as well as understand them in their context. This then provides the requisite flexibility to draw more appropriate conclusions at the company, portfolio, and country levels, creating increasing confidence throughout the process.

Where confidence in a financial system is instilled, resilience follows. And where there is resilience in a financial system, the risk is lessened for all concerned, better decision-making occurs, and wider uptake of green financial initiatives is seen as a result. The aim must be, as discussed with regards to innovation, to establish trust in data, and wider willingness to collaborate with and share that data in order to create the required system value. The obvious reference point here is again the FAIR Guiding Principles for scientific data management and stewardship.

One example of the danger of not adhering to FAIR sharing of data would be infrastructure developers building property in areas prone to flooding. Should the likes of a pension fund invest in the property developer, it is likely to lose its shareholders' money, reducing their resilience, putting strain not only on their personal finances, but also those of wider society which will likely shoulder the burden of additional care. There is a need therefore of greater disclosure of risk to Environmental, Social, and Governance (ESG) factors, so as to enable greater trust and reassurance with respect to any business engaged in environmentally impactful activities.

Without these kinds of disclosures and accountability of actions, particularly where green initiatives are concerned, businesses of all types open themselves up to questions about their practices, investments, and supply chains. Indeed, worse than simply not being able to prove positive intentions, this behaviour serves only to undermine confidence in green finance. Traceability and accountability are what give geospatial data its power in supporting financial decision-making in business and society as a whole. Such traits create the confidence in supply chains, investments, and green initiatives that generates the resilience necessary for a shift to system-based thinking in financial transactions. An example of this kind of system-based approach in action is ESG. ESG brings to the fore a firm's consideration of its exposure to material climate change risks, and integrates this into its business, risk, and investment decisions. It necessarily relies heavily on geospatial data.

No financial institution or business can be expected to effectively fight climate change by themselves. But with increased collaborative efforts to fund the accumulation of geospatial data, making it more readily available, reliable, and consistent for use in the likes of ESG, businesses are more easily able, and indeed, inclined to shift away from climate-risk activities and increased confidence in green investment and decision making will be seen.

Connecting for
Positive Change.

Resilience & Adaption

- Creating resilience and adapting to change
- Data as a building block
- A systemic approach

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Creating resilience and adapting to change

The contribution of Working Group I of the Intergovernmental Panel on Climate Change's (IPCC)[8], broadcast at COP26 showed widespread rapid changes in the climate system, globally, not just in increased temperatures, but also in changes in the patterns of precipitation, sea level rise, loss of ice extent, and increases in greenhouse gas concentrations, among others. Protecting the planet in the face of such changes requires building resilience within the systems that operate so that they are better protected in the future and adapted to specific challenges that are found in various communities and regions. The two concepts are closely related, yet distinct, and it is intended that they are explored here.

Adaptation is the more incremental of the two concepts. Those affected by certain challenges change, or adapt, their behaviour or infrastructure to accommodate to this challenge. An example would be overly busy roads; an adaptation approach would be to expand the road to add more lanes and accommodate more cars. Adaptation is necessary to a vast number of the Earth's population simply for survival, such as in the face of unpredictable extreme weather events. It requires a great deal of attention from climate scientists, engineers, policymakers, and the like to prevent immense harm done to those least able to cope with it.

Resilience is a longer-term objective. It means creating systems and infrastructure that can withstand shocks and changes as and when they occur, wherever they occur. To continue the previous example, in the face of a challenge like overly busy roads, one solution providing resilience might be to better connect the whole transport network, as explored in the Transport chapter. Achieving this requires a more fundamental examination and rethink of existing processes, business models, and overarching systems. This will determine where the weak points are, and how they can be strengthened so as not to fail, without negatively impacting the rest of the system.

Creating resilience is, at its core, an economic issue. If the economics of a system are resilient, then political will and momentum can build out from it accordingly. This can be seen with the likes of the United Nations' Reducing Emissions from Deforestation and Forest Degradation (REDD+) initiative, which encourages developing nations to reduce emissions and remove greenhouse gases through forest management and enhancement of forest carbon stocks. REDD+ provides the technical and financial support to developing nations based on their efforts and helps devise national strategies for their continued implementation. In this way, the environment is protected thanks to a more resilient financial system in which local communities need not turn to deforestation as a means of earning a living if results can be sustained over time. In fact, the opposite is the case, they are encouraged and supported in becoming stewards of the environment.

The use of geoinformation helps countries identify the drivers of changes, in particular forests, which can in turn help the development of policies to protect, restore, improve forest management relevant ecosystems and conserve biodiversity.

The only caveat to this would be the instances in which money promised by nation states to local communities and indigenous peoples does not necessarily reach them. This is often due to the presence of intermediary actors who claim a share, if not more, of the resources. Practices such as this risk antagonising the intended recipients, who do not see the benefit to running or participating in running such projects going forward. Safeguards must be put in place that prevent such occurrences, and thus to ensure the future success of engagement initiatives.

Case Study:
Using geospatial data to support the protection of rainforests

The Coalition for Rainforest Nations (CfRN) helps implement the REDD+ initiative through facilitating the use of the best data available, including geospatial information, to inform their national greenhouse gas inventories and ensuring that their REDD+ submissions to the UNFCCC are consistent, as accurate as possible, complete and transparent. Geospatial data has been very useful to identify the changes in land use/land cover through time, to generate estimates of emissions from forest, cropland, grassland, wetlands, settlements and the corresponding trend. Emissions from fire and other disturbances, such as selective logging, are also supported by data generated by satellite imagery and other supplementary information. As IPCC indicates in the report from WG III (Mitigation), limited access to technology, data, and know-how is a barrier to the implementation of mitigation activities. In this respect, CfRN not only provides access to technologies that help support the needs of its member governments, but also has intense capacity building initiatives to create the domestic competences to manage their land and territory.

“Creating resilience is, at its core, an economic issue. If the economics of a system are resilient, then political will and momentum can build out from it accordingly.”

8 IPCC Sixth Assessment report

Data as a building block

It is said that you 'cannot change what you cannot measure' and geospatial data has been central to estimating and understanding current trends and predicted effects in climate change, based on climate models under different future socio-economic development. It also forms the basis of hazard assessments and risk identification for many climate researchers when seeking to create more resilient environments and necessary adaptation plans. In this way, geospatial data helps monitor the impacts of climate change that are difficult to predict and offers early warning of any divergences from expected norms and projections. Examples of this include ice sheet collapse, and rapid changes in ocean circulation.

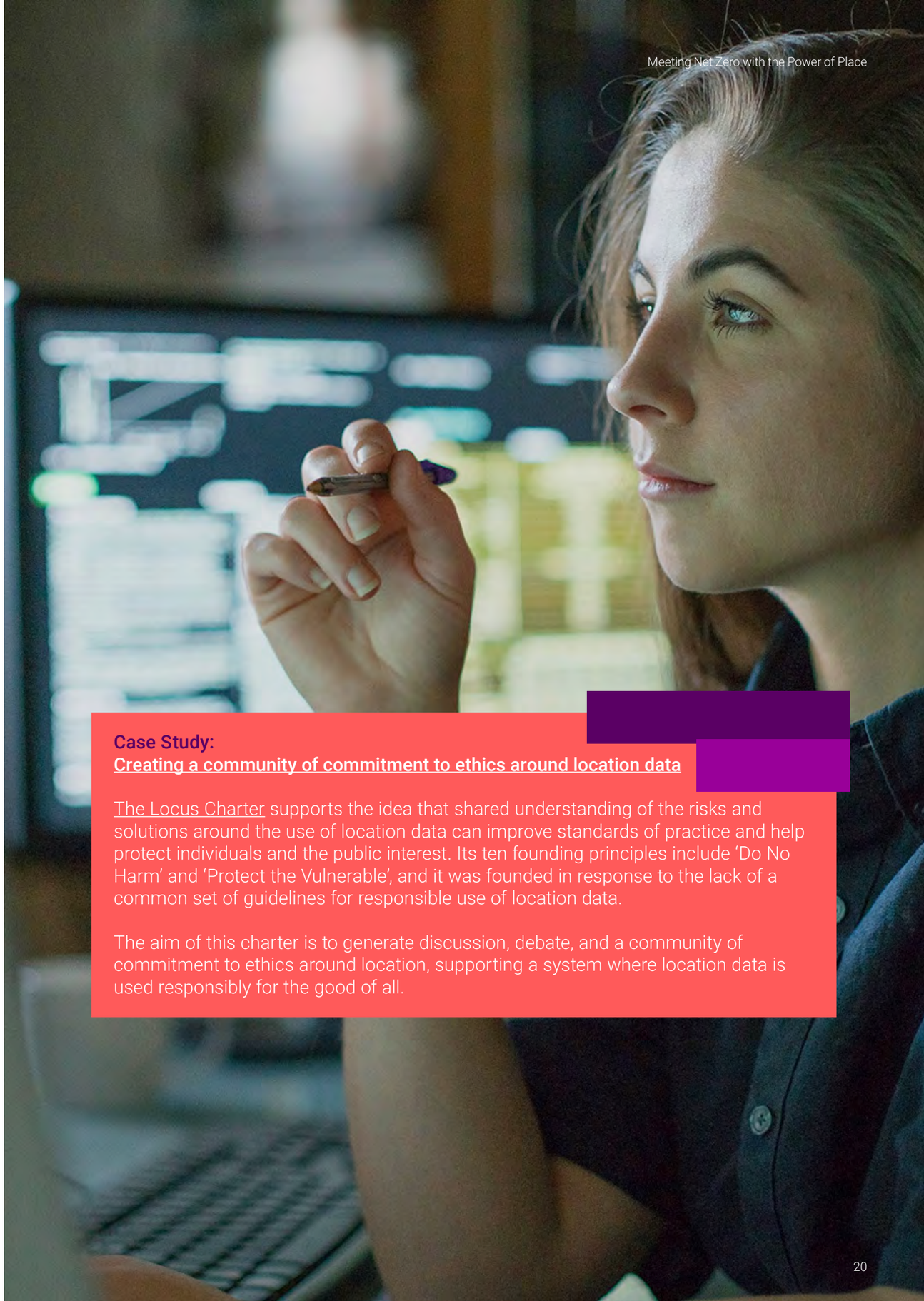
Making geospatial data and the information it provides widely available must therefore be the priority in order to plan necessary adaptations and build greater resilience on local, regional, national, and global scales. To do so necessitates a data architecture, that is, a framework through which stakeholders in establishing resilience and adaptive measures can gain the intelligence they require to undertake meaningful work. This is being attempted by the likes of OGC, as discussed around innovation, who aim to connect invested parties in environmental action, whether researchers, financiers, those developing solutions, or those on the frontline of climate change. Their session at the pavilion entitled 'Concepts of FAIR Climate Change Services' explores the design and implementation of location-based climate systems that meet the requisite level of interoperability and sharing of data, as does Ordnance Survey's session 'Applying Geospatial Information to Climate Challenges'.

Underpinning a data architecture is a requisite trust in the data itself: its provenance, reliability, and reusability. Initiatives to this effect have also been mentioned previously in this report - the FAIR Guiding Principles in particular. Of note also is the World Meteorological Organization's effort towards a code of ethics within the climate service sector. Intended as a framework delivering clear guidance for those working and consulting on climate services, the aim is to empower the community with a transparent structure that ensures the quality and standards of the data.

It is no stretch to say that climate service providers should be held to the highest ethical standards and consider the consequences of information they generate on decision-making and adaptation. Without such reassurance, and without a standard of quality that can be relied upon both locally and internationally, there is little hope for effective, collaborative work that is meaningful for both researchers and those most affected by climate change.

The Global Partnership for Sustainable Development Data's 'Data For Now' initiative is an illustration of data partners actively collaborating to achieve this goal. The initiative aims to increase the use of robust methods and tools to improve the timeliness, coverage, and quality of SDG data, through greater global collaboration and partnership, technical and capacity support, as well as information sharing. It is backed also by the World Bank, the United Nations Statistics Division, and SDSN TReNDS.

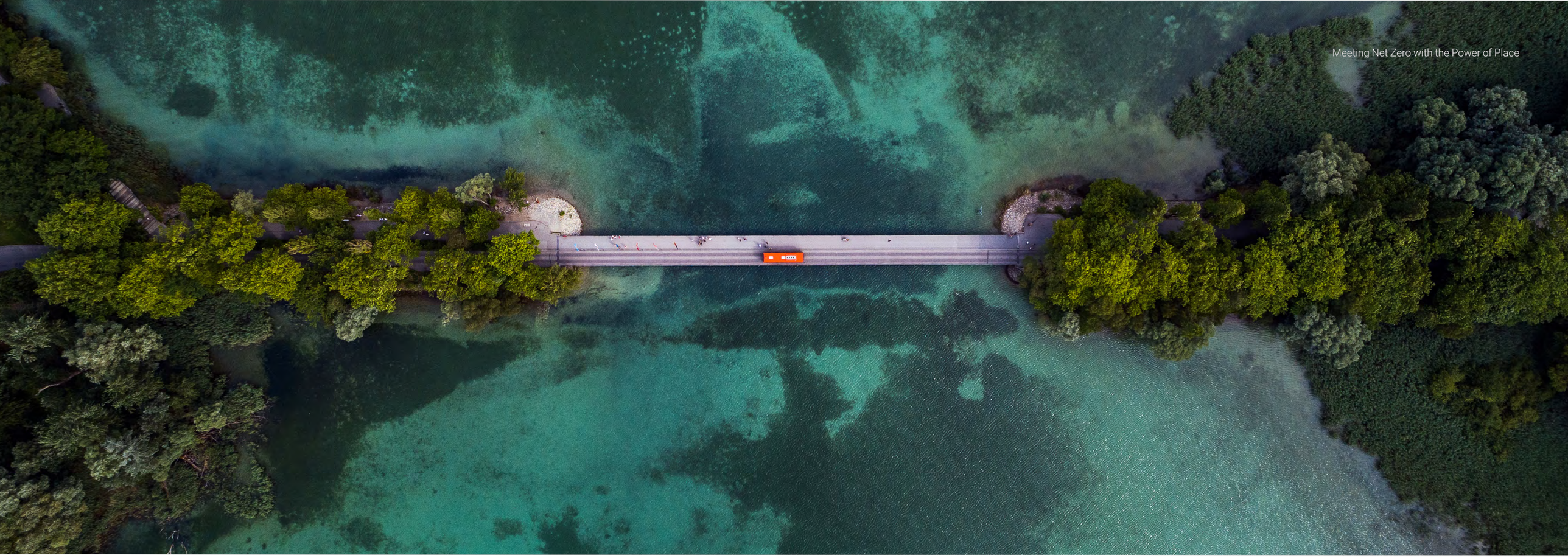
A further example of data traceability in practice is that of the UK Space Agency-chaired, politically neutral Space4Climate initiative. The initiative's goal is to ensure a seamless supply chain of trusted climate intelligence from space. In this way, it aims to support the development of quality assured products and services which enable climate-smart decisions, disclosures, and climate-sensitive planning to ultimately create more resilient, better adapted environments.



Case Study:
Creating a community of commitment to ethics around location data

The Locus Charter supports the idea that shared understanding of the risks and solutions around the use of location data can improve standards of practice and help protect individuals and the public interest. Its ten founding principles include 'Do No Harm' and 'Protect the Vulnerable', and it was founded in response to the lack of a common set of guidelines for responsible use of location data.

The aim of this charter is to generate discussion, debate, and a community of commitment to ethics around location, supporting a system where location data is used responsibly for the good of all.



A systemic approach

Initiatives such as those mentioned above will be instrumental in aiding developing nations fight climate change, where accessing the necessary data remains a huge challenge due to factors such as undependable internet access and weak mobile services. Additionally, it gives developing nations a voice on the international stage, where they are typically the least heard. This voice is then strengthened through the introduction of international quality control, standards, and certifications for climate change work.

Creating resilience against future climate events and adapting to present-day climate challenges is therefore as much about the work done to remediate and mitigate its effects as it is putting in place the correct structures and standards into a coherent system which will enable a consistent, quality approach to that work. This is paramount to global efforts, as those facing global warming's greatest effects are often those who need the most help to combat them. With uniform standards and assured quality and access to data, the opportunity for collaboration is greatly increased, offering hope to areas where previously there was little.

Digital twins can play an important role here, using simulations to stress-test the system as a whole to inform better decision making. It is here that geospatial intelligence becomes business intelligence, to enable more resilient and effective decision making.

Case Study:
Developing more resilient systems to withstand climate challenges

Prescient Earth from Canadian and UK based company Sparkgeo is an Earth observation tool that seeks to make sense of geospatial data. Through integrating the platform into their workflow, Simulations can be run and analyses can be performed on a wide range of location-based data. It enables them to access and transform petabyte-scale data, from sensors and IoT to third-party sources and internal datasets. In doing so, it allows the development of more resilient systems that provide a more sustainable alternative than at present and can withstand the challenges posed by climate change. An example of this would be that of Digital Twins, whereby near real time virtual models of a location or infrastructure can be tested and remodelled under an infinite number of scenarios, at no cost or impact to the physical entity under observation. Efficient, systematic planning of environments in this way offers a much greater chance of resilience when such environments come to be tested in the real world. Prescient Earth Sparkgeo benefits from the opportunities brought about by its workflow integration.

Connecting for
Positive Change.

Nature

- Nature-based solutions to climate change
- Supporting Indigenous peoples to protect and restore biodiversity
- Creating stewardship through data accessibility
- Allowing natural governance

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Nature-based solutions to climate change

Land use change is a key challenge facing ecosystems globally. Through converting natural ecosystems into productive land, huge biodiversity loss has occurred. Palm oil production, for example, is illustrative of this. While palm oil is an extremely efficient crop in its tonnes per hectare (t/ha) yield, delivering around 3.3 t/ha compared to around 0.7 t/ha for sunflower or rapeseed[9] - hence its near-ubiquity in common products - it still requires conversion of vast swathes of land for its production. This has made palm oil a major driver of deforestation in some of the world's most diverse forests, replacing them instead with monocultures that threaten, if not eradicate entirely the habitats of already endangered species.

Losing forests in this way has an immense impact in climate terms. Primary forests sequestered around twice as much CO2 as they emitted between 2001 and 2019[10], meaning they offer a 'carbon sink' to the Earth's atmosphere. They absorb a net 7.6 billion metric tonnes of CO2 every year, which is 1.5 times more carbon than the United States emits annually.[11] It appears evident, then, that forests themselves are something of a solution in the fight against climate change, of the type called 'nature-based solutions'.

The European Commission defines 'nature-based solutions' as those inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social, and economic benefits, and help build resilience. In short, they leverage the natural world itself as an able player in decarbonising the atmosphere, rather than utilising manmade technology and infrastructure.[12]

Nature-based solutions can help play a crucial role in the fight against climate change. In fact, it is estimated that they will provide around 30% of the mitigation needed to meet the goal set by the Paris Agreement of no more than a 1.5C increase in global temperature by 2030.[13]

Nature is often overlooked as a solution for climate change by policymakers, especially compared to technology-based remedies. This is perhaps due to the perceived optics of allowing nature to restore itself, rather than intervening. Furthermore, it has been challenging to assign measures or figures to nature, hence the work of the Taskforce on Nature-related Financial Disclosures (TNFD) and others to develop and deliver a framework for organisations to report and act on evolving nature-related risks, with the ultimate aim of supporting a shift in global financial flows away from nature-negative outcomes and toward nature-positive outcomes.[14] Many policymakers would rather be able to point to investment in a new technology as means of showing they are actively combatting a problem, than by appearing to stand by and allow the problem to right itself. Yet the potential to draw on the natural world as an alternative to investing further energy and resources into the design and manufacture of synthetic technologies is vast. Allowing nature to reassert itself through encouraging nature-based solutions is not doing nothing; it is itself an active choice, one that has far greater potential for positive environmental change than has previously been credited.

> Allowing nature to reassert itself through encouraging nature-based solutions is not doing nothing; it is itself an active choice.

Case Study:
Using geospatial data to monitor deforestation

Started in 2014, Global Forest Watch monitors deforestation in real time around the world. Currently monitoring 600 million hectares of forest at any one time, this provides an incredible data resource, and it is hoped to be expanded to monitoring other types of land for the same purpose. Its collaborations have included the Amazon Conservation Association (ACA) whereby illegal mining and logging in protected areas have been quickly detected. Through sharing this data with governmental authorities, the ACA has enabled action to be taken against the activities with 24-48 hours of receiving the alert. In this way, the Global Forest Watch and the ACA are demonstrating the most salient points in the use of geospatial data in the fight against climate change: collaboration, ease of sharing, remote accessibility, low barrier of entry to use, immense reach, and more.

9 WWF-Germany, 'Searching for Alternatives' - Comparison of global oil yields in tonnes per hectare.
10 Nancy L. Harris et al., 'Global maps of twenty-first century forest carbon fluxes.' Nature Climate Change - January 2021
11 https://www.wri.org/insights/forests-absorb-twice-much-carbon-they-emit-each-year
12 European Commission, 'Nature-based solutions.'
13 IUCN and Oxford University, 'Nature-based Solutions in Nationally Determined Contributions: Synthesis and recommendations for enhancing climate ambition and action by 2020.'
14 https://tnfd.global

Supporting Indigenous peoples to protect and restore biodiversity

Biodiversity is declining at an unprecedented rate everywhere, but the rate is lower in areas where Indigenous peoples own land.[15] Recent research shows that at least 36% of the world's "intact forests" - which play a critical role in sequestering carbon and protecting biodiversity - are located on Indigenous lands and are better preserved than in non-Indigenous areas. The root of success lies in the diverse knowledge systems of Indigenous peoples that honour and respect our complex interdependence with nature.

Indigenous peoples and local communities traditionally own more than 50% of the world's land, yet governments officially recognize only 10% of their property rights. The Intergovernmental Panel on Climate Change (IPCC) has recognised that strengthening the rights of Indigenous peoples is a critical solution to the climate crisis. Further action is urgently needed to support legal recognition of Indigenous peoples' collective and resource rights, to ensure that Indigenous peoples are equal partners in policy development, and to achieve adoption of the United Nations Declaration on the Rights of Indigenous peoples (UNDRIP), which promotes the full and effective participation of Indigenous peoples in all matters affecting them.

The GEO Indigenous Alliance is developing a new nature-based concept: "Indigenous-nature-based" (INbS) solutions, which is based on Indigenous cultural values and supports Indigenous self-determination.

Case Study:
Preserving Indigenous Cultural Heritage through the use of geospatial data

The GEO Indigenous Alliance was founded by Indigenous representatives at the Group on Earth Observations (GEO) Canberra Ministerial summit in 2019. Its aim is to protect and conserve Indigenous Cultural Heritage through the use of geospatial data and technology in order to create a more sustainable planet. Bringing together Indigenous peoples from around the globe, the GEO Indigenous Alliance shares Indigenous-led innovations to combat climate change along with discussing Indigenous data sovereignty and data management. In this way, it provides not only a voice, but the mechanism by which Indigenous peoples are empowered to directly affect their local communities and environments. By bringing Indigenous knowledge to the fore, it enables better stewardship of regions from those who know it best, and can use the available geospatial data to its maximum effect.

15 https://ipbes.net/news/Media-Release-Global-Assessment#2-Indigenous

Creating stewardship through data accessibility

Establishing nature-based solutions and creating stewardship within local communities is greatly assisted using geospatial data. Researchers and policymakers are afforded immense opportunities to see and track land use change in every corner of the globe thanks to satellite imagery and emissions measurement equipment. However, this data and the intelligence it offers to create tailored, region- and even community-specific solutions must become more readily available and affordable if it is to provide the maximum benefit. Developing economies still often see the use of geospatial data as prohibitively expensive, though costs are decreasing, meaning it is more viable than ever to access, however this is more than just an issue of cost. There are also barriers when it comes to the skills and capacity to work with the data, analyse it, as well as having the right equipment, access to electricity, and internet access.

NASA's Landsat and ESA's Copernicus programmes, for example, provide multi-spectral imagery of the Earth's surface. This satellite imagery not only delivers pictures but also contains many layers of data collected at different points along the visible and invisible light spectrum and is at a scale that enables observation of both natural and human-induced change. Due to its free and open data policies, and assuming additional barriers such as skills and capacity are overcome, even the most vulnerable communities can access the information needed in understandable form, to withstand and adapt to extreme climate issues such as drought, flooding and fire, as well as protect these natural mitigations to climate change. The access to this huge amount of data is now being facilitated, even for the most remote Indigenous communities, by new connecting capacities coming with internet from space and international programs such as the Giga UNICEF-ITU Initiative.

The programmes are an invaluable resource, but there must also be accompanying initiatives towards developing a strategy that brings together Indigenous experts responsible for their ancestral homelands and policymakers, technology providers and the scientific community, so as to unlock geospatial tools and data and create a truly systems-based approach to nature-based solutions. The Group on Earth Observations (GEO) shows that there is recognition of this, as well as the need for co-design and co-production of tools and services through training and long-term capacity development. GEO exists as an intergovernmental partnership focused on improving the availability, access, and use of open Earth observations and filling in gaps in existing knowledge, to impact policy and decision making. By doing so it provides a framework for all stakeholders to bring forward their diverse perspectives to work together in the fight against climate change.

Allowing natural governance

Getting the best value and use out of satellite data sometimes means making profound changes to the way industries work and the way in which they are governed. This can take time and effort on the part of nations, but it is this kind of effort that will pay dividends in the long term. While catching individual instances of unsustainable land use through satellite data is no doubt worthwhile, it is important that countries go one step further to identify the trends and patterns that need altering if they are to make the most of what satellite data affords them on a wider scale, and ideally putting this into national policy to effect change. Aiding nations, policymakers, along with key stakeholders such as Indigenous communities will require high levels of collaboration and sharing of data. Simply barring those working their ancestral land from doing so will either push them elsewhere, repeating the problem in another location, or worse, wreak irreparable damage to the community itself. Instead, it is better that all interested parties work together and use the data to seek a solution through compromise.

When land use is examined, the ability of geospatial data to aid monitoring and understanding of various environments offers a better understanding of the nature-based solutions that can be developed against climate change. Land use itself is responsible for around 23% of global emissions,[16] so it is vital to make greener use of it by any means. What's more, poor land use and destruction of certain areas can lead to increased risk of landslides, extreme weather patterns, and more disasters which disproportionately affect those least prepared for and able to deal with them. This quickly turns local problems into global problems. It is in everyone's interest that local, Indigenous communities are included in the conversations and co-design the change by continuing stewardship of their land unhindered and widely consulted when increasing the use of nature-based solutions to address climate change.

Case Study:
An early warning system in the fight against deforestation

Utilising optical sensors onboard the Landsat 8, Sentinel-2, and China-Brazil Earth Resources Satellite (CBERS-4 and CBERS-4a) satellites, the Near Real Time Deforestation Detection System (DETER-B) can detect deforestation in areas smaller than 25 hectares. Building off the previous work of DETER, it also presents higher detection capability in identifying areas between 25 and 100 hectares. This gives researchers and policymakers an early warning system in the fight against deforestation, enabling the fastest responsive from enforcement agencies on the ground to slow down or stop deforesting activities. DETER-B also provides visibility of the changing nature of affected areas, providing greater intelligence to those working within the wider sphere of climate change, whether researchers, innovators, financiers, or more. Currently only operational in Brazil, with data sent daily to the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA), DETER-B is managed by that country's National Institute of Space Research (INPE), itself a part of the Brazilian Ministry of Science, Technology and Innovations.

16 IPCC, 'Special Report: Climate Change and Land.'

Connecting for
Positive Change.

Built Environment & Cities

- The increasingly urbanised future
- How can geospatial data and technologies help?
- The journey – hurdles and opportunities
- Climate risk and natural disaster – geospatial for the growing urban populous
- No two human geographies are entirely alike
- How to get there? Build trust to empower collaboration
- The future is geospatial for the built environment

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The increasingly urbanised future

Over 50% of the global population currently live in urban areas, with this figure projected to rise to around 70% by 2030[17] – meaning cities will become home to billions more people. By far the majority of this change will be in the Global South.

Whereas in developed economies most cities are relatively static in size, in the Global South migration from rural to urban areas, already the major contributor to unchecked expansion and squalor in many cities, is set to provide urban planning authorities with a fresh wave of challenges as they seek to deliver sustainable, liveable urban environments. Amongst these challenges are demand for affordable housing, cost-effective and efficient transport and mass transit systems, utilities, basic services including health and education, food and jobs. All of which increase the pressure on existing systems: man-made systems such as energy, agriculture, and supply chains; natural systems such as forest, marine, and atmospheric. Planners need to build resilience at pace in the face of continuing climate change and the increasing frequency of natural disasters including flooding, earthquakes, fire and drought.

That most of these current and future cities are low-lying/coastal, often on unstable, flat former marsh lands brings into sharper focus the need to effectively address, adapt to and overcome or accommodate the challenges of providing sustainable urban environments, and quickly.

17 United Nations Department of Economic and Social Affairs, 'World Urbanization Prospects: The 2018 Revision.'

How can geospatial data and technologies help?

Fundamental to the delivery of the appropriate infrastructure, systems, and services, in the right place and at the right time, is data. In a planning context virtually all data is geospatial in one form or another – whether it is "mapping", sensor data, a digital twin, a 3D model or BIM, demographic data, environmental observation, or even utility infrastructure performance. The data set in question can therefore be linked to a location, a street, an address, a building, a land parcel, a road segment, a bus stop, a water hydrant etc. Harnessing existing data from existing systems, public and private, is intrinsic to enabling planners, architects, service providers, policy makers, and investors to understand the type, location, and quantity of need in any given environment. This is the baseline for helping to design and deliver more resilient built environments.

Geospatial data helps, then, as the foundation, the building block. By bringing different data sets together planners can begin to generate information and insight, to understand patterns and trends, to model impacts, develop scenarios, and plan imaginatively. Even in developed economies this is something of a nirvana and it is useful to step back and ensure that in stepping forward, planners and others do so fully aware of some of the barriers to an effective data-enabled plan (true in any environment but all the more pressing in urban environments in the global south for the reasons cited).

Case Study:
Developing more resilient urban environments

Two of the UK leading geospatial enterprises have delivered geospatial data platforms – Esri UK for Homes England and CGI for the Welsh Government. Both reflect the recognition that access to and sharing of multiple datasets aids urban planners in designing and delivering projects. These 'single sources of truth' are standards-based platforms bringing together disparate data sets including land preservation, biodiversity, road surface types, and much more, enabling replacement of paper-based manual processes. Planners can, for example, identify potential development sites using geospatial data including flood alert areas, local authority green belts, local transport hubs, and drone footage. Basing decision making on up-to-date data that factors in sustainability, net zero, and resilience enables more considered planning and more resilient urban environments.

The journey — hurdles and opportunities

Although far from unique to planning, one of the biggest challenges organisations face, one that 'digital transformation' seeks to overcome, is finding, accessing, interacting with (thanks to the use of standards driving underpinning interoperability) and reusing existing data sets, whether static or dynamic of the necessary quality (together sometimes termed the FAIR or Q-FAIR Principles). This is often presented as an issue of siloes and while it is true that there are data stovepipes in and across all organisations, these can be a product of institutional legacy where domain expertise and IT investment have been, understandably, either guarded or ring-fenced. The consequence is that organisational data may be split across many internal systems including GIS for mapping, CAD for design, ERP for case and document management systems, for example.

Owing to fragmented IT and other factors, today's urban planners and policy makers alike can find it very hard to assimilate and interrogate coherent, consistent data - spatially or otherwise - in any sustained and meaningful way. Planning decisions might then take place without the full knowledge or understanding of the existing environment or need. On top of which, while design is often considered a digital leader, the construction industry itself is considered something of a digital laggard, slow to migrate from CAD to the world of collaboration implicit within BIM and digital twins, themselves inherently geospatial.

Adopting FAIR principles helps recognise and overcome many of the technical challenges associated with deriving planning and development insight and value from the variety, volumes and increasing pace of what are very dynamic data streams. At all times though it is essential that human need is not subservient to the data but those outcomes are rather reflected in the planning outputs and then delivered by the authorities and their contractors.

While there may be regulatory/policy drivers, (in England and Wales, for example, planning officers are limited in what factors are material to the approval process) the consequence of an uninformed planning decision can be seen in something as every day as asphalting a garden. Individually, it has a low carbon impact change in land cover; collectively, however, 100 or more such changes presages significant carbon impacts, stimulates hotter built environments, accelerates runoff and reduces permeability, increasing flood risk locally and downstream. This can be seen in major urban centres where long established drains have been filled in or used for casual dwellings in cities such as Accra and Bangkok.

With better access to and use of data, particularly geospatial data, planning authorities are better equipped to understand need, location, risk, and the cumulative effect of development and adapt accordingly.

Climate risk and natural disaster — geospatial for the growing urban populous

Often two sides of the same coin, 'climate risk' and 'natural disaster' are sometimes used inter-changeably but do require differing perspectives. Some four billion people have experienced climate-related disasters in the last 10 years.[18] This number is set to increase substantially in the next decade as global warming further takes a hold of all Earth systems, atmospheric, oceanic, forest, desert, polar, tundra and urban. The impacts are seen most intensively in built environments so the challenge is to equip both cities and their populations with the infrastructure, resources, and knowledge to make both as resilient as possible.

Areas with the most rapid increases in urban population often experience the worst effect of climate change. This is because such rapid growth is often less regulated and unplanned, leading to the increased likelihood of a hazard event becoming a major emergency. Digital enables the extension of established participatory methods to the design, adaptation, and development of these new and growing urban areas. These techniques put visualisation at the centre of engagement; open, cloud-based tools[19] democratise data access and stimulate collaboration and shared ownership of ideas for more resilient communities in the long term as well as enabling response to natural disasters as and when they occur.

Case Study:
Mapping informal settlements to support infrastructure development

To promote prosperous, inclusive, and resilient urban settlements, Zambia was keenly aware that there was insufficient understanding of informal settlements and dated small-scale geospatial information. Ordnance Survey led a project to map informal settlements to help policymakers develop infrastructure - for example, sanitation, drinking water and vaccination centres - more efficiently, and thus with a lower carbon footprint. The use of satellite imagery and automation has led to the creation of a high-quality base map faster and more efficiently than previously and enabled more accurate demographic understanding. These tools are becoming the template for a new generation of urban planners around the world, underpinning more systemic planning going forward.

18 UN Secretary-General António Guterres, 'Remarks to the World Leaders Summit – COP26 – 1 November 2021.'
19 For example OGC's Cloud Native model

No two human geographies are entirely alike

Asia, Sub-Saharan Africa, Latin America, and the Caribbean all experience high levels of climate-related natural disasters, with an accompanying high level of movement of people. These often flat, coastal regions are also home to some of the greatest unplanned peri-urban conurbations in the world, making them some of the most vulnerable places in the world to climate change.[20] As populations increase, demand concentrates and presses on the peripheral and more extensive natural systems, widening the potential for large scale impact from natural disasters, especially drought, when not only rural economies fracture but urban dependency is imperilled.

For the authorities, knowing when and where to intervene is essential. That means understanding risk, resourcing people and places through knowledge and infrastructure and having actionable response plans when disaster strikes. Again, geospatial data and tools facilitate that response. The May 2015 earthquake in Nepal, for example, saw collaboration between the government and NGO MapAction in using satellite imagery to validate affected areas and coordinate smooth and effective action. While satellite imagery has become a commonplace in natural disaster rapid response[21] and the media, the wider role of geospatial data integration, analysis, and modelling gains less attention but is if anything even more critical to developing effective long-term built environments.

Where natural disasters occur, it is the sharing of the geospatial data, the 'democratisation' of it in effect that has enabled the swiftest, most effective responses. Simply having more data is not enough, it is the smart use and de-siloing of data that is crucial to withstanding and hopefully averting the very worst disasters. The same is true where climate change is forecast to impact with time series data, 3D models, and extensive modelling hopefully yielding benefits in decades to come.

> "Simply having more data is not enough, it is the smart use and de-siloing of data that is crucial to withstanding and hopefully averting the very worst disasters."

20 Liz Hughes – Chief Executive, MapAction, 'Supporting Urban Emergencies.' (30:30)
21 Tacloban in the Philippines is another example where imagery allowed sufficiently accurate mapping of the area of the pre-landfall anticipated storm surge to enable response teams to redirect their efforts to where they would be most effective ahead of time, saving time and lives.

Case Study:
Building a detailed map of underground infrastructure

Few countries have a single detailed map of all the pipes and cables beneath the surface. In the UK the Geospatial Commission is working with utilities, telecoms, local authorities and other infrastructure owners to develop a new digital platform for sharing and accessing data about the subsurface. The ambition is to reduce the likelihood, and therefore cost, of accidentally striking an underground pipe and cable by mistake, while helping to improve the way works are planned and carried out. In this way, it will make the likes of digging under roads safer, reduce congestion, and help support other initiatives such as the move to electric vehicles. Key to the success of the new platform, known as the National Underground Asset Register or NUAR, has been working jointly with infrastructure owners themselves to identify the non-technical requirements (legal, commercial, security, safety), which if not addressed will act as a barrier to effective data sharing. In meeting these requirements, NUAR is also helping to inform other infrastructure and related public-private data projects.

How to get there?
Build trust to empower collaboration

The collective intelligence afforded by geospatial data is itself an immensely powerful tool in gaining support from the many skilled professionals around the world to work in an increasingly interdisciplinary manner, and aid and enhance decision making processes especially in response to natural disasters. By allowing geographically disparate experts remote visibility of pertinent data, better courses of action can be taken sooner, as was seen in Nepal in 2015.

Productivity can be maintained, and often raised, even as increasing numbers work from home, while carbon emissions are reduced. In the longer term that collaboration must take a different form, aiming to equip and support institutions and communities to build, adapt, and develop their communities in response to an understanding of the wider impacts on the horizon and using up-to-date data and tools to share, communicate, and collaborate.

To create a system where this level of collaboration is regularly achieved on the widest scale, many different factors need to align.

- Shared vision and values
- Transparency – open standards, open data, open algorithms
- Community-engaged, needs-driven, data-enabled, outcome-centric – consultative, ethical, multi-lingual, accessible, iterative, adaptive
- Effective timely delivery throughout – grand plans, incremental gains

These will build the necessary trust required for better collaborative working: in the data used, in different, often competing, professional and governmental bodies, and in the platforms and mechanisms by which the data is shared. The technologies that enable all this come a distant second to the goodwill needed to make it happen.

The future is geospatial for the built environment

Geospatial data has an immense role to play in the future of built environments and cities. Not only does it furnish professionals with the information required to support improved sustainable urban planning, but it also underpins emergency response decisions.

By adopting mechanisms that help build trust in the value and purpose of this type of information, such as transparency, the use of standards, the ability of others to access the data, participatory approaches to development decisions, and so on, communities - established and migratory - can come to collaborate and cooperate with and adapt to the evolving urban environment. Such collective 'ownership' equips communities and their leaders as well as those fighting climate change with the information, insight, and knowledge to engage with and help sustain the resilient urban fabric and systems.

Resilient communities in sustainable cities are less likely to suffer the iniquities of poor urban development, climate change or climate emergency. Geospatial data and technologies better equip them to achieve this and so much more. Overcoming some of the barriers to this objective, such as adoption of standards, the breakdown of data siloes, transparency by default, and open collaboration with affected communities will see resilience more easily established.

Case Study:
Harnessing measurement to fight climate change

"You can't manage what you don't measure."[22] While there is (rightly) sensitivity to what it is you can see from space (let alone planes and drones or divine from your telephone or social media usage) the current reality is that we live in an increasingly sensed world. Indeed, the free internet only exists thanks to effective population segmentation for advertising. Institutions, public or private, have until recently been less subject to this level of surveillance, but democratisation coupled with technical evolution enables regulators, activist shareholders, and others to increasingly hold business, industry, and government to account. The Satellite Applications Catapult built open global data sets of steel and cement facilities to enable others to track activity on a site-by-site basis. And now start-up Satellite Vu is poised to launch satellites that seek to be the 'World's thermometer', able to measure the heat emissions from any building on the planet: finding the "sick" buildings that are wasting energy and are ripe for thermal efficiency upgrades or informing ESG-policy-aligned action. The ability to quantify a problem that always existed, but to a previously unknown extent and on an unknown scale, is a vital tool in the fight against climate change.

22 Peter Drucker

Connecting for
Positive Change.

Transport

- The future of transport using geospatial data
- Achieving user-centricity
- The required data for systems-based transport

Innovate UK
KTN

The future of transport using geospatial data

Like built environments and cities, transport has grown somewhat arbitrarily over time, and there are precious few examples of holistically designed and implemented transport networks. For example, if a person wishes to cross a single city, they are often required to use several different services and providers, pay individually at each, and take several different modes of transport. These modes are discrete and not necessarily the most efficient or sustainable means of moving, and furthermore, each provider holds its own data and operates solely to generate profit. The same is the case for moving goods.

While transport is responsible for about 16% of all global greenhouse gas emissions, it warrants special attention with regards to sourcing green alternatives. Like all topics in this report however, it is important that transport solutions create system value, and not simply incremental improvements. Otherwise, this will simply result in more of the same, where disparate transport services continually compete without an overall consideration for the needs of users and the environment.

Transport systems have the potential for each aspect to be integrated with all others, and the focus of this approach should be to generate a better experience for the person travelling through the system. By making the transport network user-centric, that is, by aiming for a seamless, intuitive transport experience, modes of transport will necessarily become more sustainable as they become increasingly efficient.

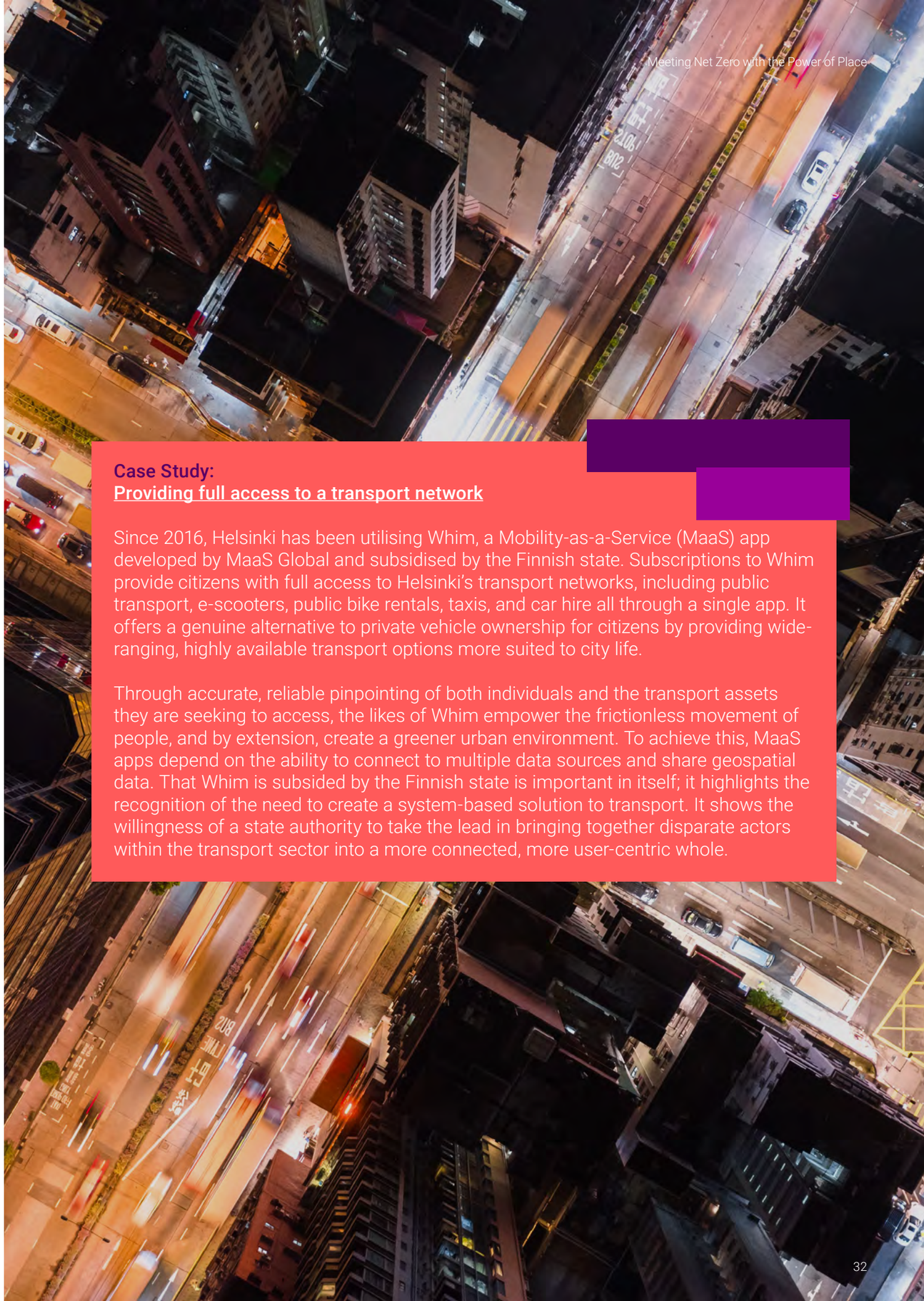
When a mobile network offers data, SMS and call minute packages, they do so knowing exactly how all customer use all of these services. This means that when they design multiple bundles, they know the statistical needs of each of their customers, which results in very few customers needs not being met. It also means they can run a non-subsidy based model, and crucially better meet customers needs.

Like mobile networks, transport operators should understand their customers better to build a Mobility-as-a-Service (MaaS) system. The challenge with MaaS, and the reason that it requires subsidising is that there is not enough joined-up data. No single source has comprehensive knowledge of national public transit habits. Organisations like Transport for London (TfL), Transport for Greater Manchester (TfGM) and Transport for West Midlands (TfWM) have only local visibility, and while some groups have data around driving, there are gaps around cycling and walking habits.

The implications of this are that, currently, the ambition of a seamless, frictionless and single payment solution and operational transport model suffers greatly and requires more subsidising. Right now, companies like Alphabet, Apple, Facebook, and Uber; via their various app suites, know more about end-to-end mobility habits than any transport authority.

If users were able to cross their city with a single ticket, knowing they were taking the most efficient route, whatever the mode(s) of transport required, it would significantly reduce waste within the network. By building a strategy for a user-centric system, more goals are achieved, not least improved health, a reduction in CO_2 levels, and improvement of air quality, as nudges towards active or low carbon travel alternatives are built.

Initiatives into multimodal ticketing, such as Uber's 2022 pilot in the UK, are underway, but commercial questions remain unanswered. For example, there are calls from the transport sector for cities to take charge of MaaS, outlining that public transit services should form the foundations of MaaS, with concerns that private companies would favour their own services in order to drive revenue in an unfair manner.



Case Study:
Providing full access to a transport network

Since 2016, Helsinki has been utilising Whim, a Mobility-as-a-Service (MaaS) app developed by MaaS Global and subsidised by the Finnish state. Subscriptions to Whim provide citizens with full access to Helsinki's transport networks, including public transport, e-scooters, public bike rentals, taxis, and car hire all through a single app. It offers a genuine alternative to private vehicle ownership for citizens by providing wide-ranging, highly available transport options more suited to city life.

Through accurate, reliable pinpointing of both individuals and the transport assets they are seeking to access, the likes of Whim empower the frictionless movement of people, and by extension, create a greener urban environment. To achieve this, MaaS apps depend on the ability to connect to multiple data sources and share geospatial data. That Whim is subsided by the Finnish state is important in itself; it highlights the recognition of the need to create a system-based solution to transport. It shows the willingness of a state authority to take the lead in bringing together disparate actors within the transport sector into a more connected, more user-centric whole.

Achieving user-centricity

Connectivity is crucial, as it is the sharing of data, often in real time, that gives infrastructure designers, route planners and vehicle manufacturers the requisite information to optimise their outputs. Connectivity has been significantly bolstered by improved communications infrastructure in many towns and cities globally. However, this is not true of all rural areas or less developed nations. In order to make the most of geospatial data for transport globally, a much wider rollout of networks to enhance connectivity will be required, or greater satellite connectivity as an absolute minimum.

What's more, while services like 4G and 5G provide connectivity, they also provide a vast amount of data. This must be used smartly, that is, the added value it affords must be obtained and made use of. This can be done through the use of AI and machine learning tools, which allow planners to make decisions and optimise networks in a more informed manner.

Electric vehicles are a prime example of the challenges and opportunities of network optimisation. As they become more common, services like 4G and 5G, and geospatial data, will become essential tools in the rollout of the necessary charging infrastructure. Planners must know where to place charging stations so as to maximise their impact and availability, and electric vehicle users will themselves require up-to-date location information on where to charge. While cellular data can show where almost everyone drives, without further geospatial data context it cannot tell anyone how to prioritise infrastructure or where new drivers will be. Both factors will have a large knock-on effect on energy generation both in terms of location and quantity, which will also feature in the discussion regarding energy.

The opportunity in optimising the transport sector is about more than simply implementing the greenest forms of transport as widely as possible, though this should by no means be discounted as an objective.

The real necessity is changing the very nature by which transport providers operate. Transport operators should seek to develop and adapt their business models away from simply profit-seeking through passenger fares, moving towards viewing themselves, and indeed operating as data companies. In this way, they will rely less on competition for footfall on their services, and instead operate as part of a wider data sharing ecosystem.

Transit operators will need to introduce more demand led services which can help serve communities better, and the better that these companies know their customers' mobility habits, the better able they are to engineer their organisation. Digitisation, data capture and explicit ring-fencing of this data so that it only solves customer-operator problems is key. There is some discussion of monetising this data, which would be a missed opportunity in the long term in terms of the greater economic, social, and environmental impact of a more representative and sustainable transport system.

No doubt the move away from simply offering tickets for particular routes and journeys is somewhat radical. It is the means by which transport providers have operated for decades after all. Yet it is too siloed and out of touch with the modern urban existence. Geospatial data, in combination with operational and logistical systems, supports people in being able to order virtually anything to their precise location within a matter of hours through apps that seamlessly integrate the likes of restaurants, payment services, and delivery companies. So why is this convenience not translating to the transportation of people? Why are residents forced to design their own routes across a number of different providers, paying them each in turn for access to a particular part of their journey? Is it any wonder why private vehicle ownership remains high, as does the resultant urban air pollution?

Case Study:
Enabling efficient electric vehicle implementation (supply side)

In shifting to electric vehicles (EVs), one of the considerations users need to consider is securing the right EV with the correct battery size for their needs. It is this which will determine their efficiency and cost-effectiveness most. ZERO is an advanced AI tool created by Dynamon Ltd which enables users to forecast the real-world performance of EVs for different battery sizes within specific operations. In this way, issues around charging, range, and economic viability are identified long before vehicles are purchased, meaning once they are, running an EV is as sustainable as possible. This has additional far-reaching environmental benefits; for example, by purchasing only the correct EV for a user's needs, the wastage within the EV supply chain is lessened, particularly around the somewhat contentious nature of lithium production. Sharing the data around EV requirements in various locations will also enable the likes of charging station planners to design a more resilient infrastructure network, one that is built systematically, not haphazardly. The number and types of charging stations, for example, could vary widely from a city centre to a port to a rural area, and this can be considered much better.

Case Study:
Using mass-scalable personalisation to accelerate electric vehicle adoption and reveal battery-rightsizing opportunities (demand side)

The top concerns prospective electric vehicle (EV) buyers have about giving up their internal combustion engine (ICE) vehicle are: range anxiety, charging deserts and ownership costs. The perception they drive more miles daily then they think, above average initial EV sticker prices and an unsurprising lack of awareness where charging points are located. A mass personalisation tool developed by EV Serious Ltd called the EV Curious (EVC) app directly addresses this by capturing and analysing their car driving habits using proprietary geospatial and sensor techniques. Then a set of battery charging simulations are run to better answer which EV might meet their unique needs. EVC even tells them their current transport carbon footprint and encourages public transit and active travel too. It is an industry sales funnel to help EV buyers transact with confidence, and help prioritise new charging point installations from next wave of EV users. It also generates battery rightsizing data to reveal a market for more cars with smaller batteries (this in turn helps more of the same battery materials go to more EVs on the road).

The required data for systems-based transport

The quantity and availability of geospatial data in transport networks is already immense, what is required is a greater sharing of this data in order to unify modes of transport towards more user-centric networks.
Pertinent data includes:

1 **Route monitoring:** This can be further split into transportation of people and goods supply chains. Firstly, knowing the popularity of certain routes at specific times enables town planners and public transport route planners to better understand the stress points within their networks, and prepare for and mitigate against them. This is not simple – a traveller driving to a train station, travelling to a major city by train, and then flying from that city's airport to another location would involve at least three silos of data.

Geospatial data that provides these insights includes satellite imagery, traffic cameras, and cellular data to show the clustering of cars on certain roads, and items such as ticket barriers at railway stations and passenger check-ins at airports. Sharing this data will prevent the creation of roads with limited need, or the putting on of additional services on quiet routes. In this way, additional vehicle emissions can be avoided at very low cost.

With supply chains too, an efficient route is one where there is minimal friction; where goods are moved from one stage to the next on time, and across minimal distance, creating the fewest emissions possible. Supply chain managers therefore must be able to visualise and inspect each step along the chain, something very difficult to do across long linear networks. Efforts such as AIS tracking via LEO satellites already exist to provide reliable transit times for goods using marine transport, but further, granular detail is still needed.

To enable this, greater collaboration is needed between the public and private sectors to monitor transport routes. These sectors are intertwined, with an interest in the successful movement of goods. For example, private companies rely on the maintenance, capacity, and routing of public roads, while the public sector needs a healthy private sector to ensure a strong economy. This highlights the need for a truly system-wide approach, and action from a range of stakeholders to truly unlock the potential of location data in the transport ecosystem. This points to the value proposition of more granular level data that is 'bottom up' rather than 'top down', telling many individual stories, rather than extrapolating a small number of stories from many data points.

Case Study:
Providing greater insight into shipping patterns

As the number of wind turbines across coastlines increases, there is an increased risk to those shipping and navigating through coastal waters. UK maritime bodies including The General Lighthouse Authority (GLA) and Trinity House are advocating the need for greater insight into shipping patterns through UK waters to help determine how future wind farm expansion will influence shipping routes. Geospatial software company Emu Analytics is utilising its real time and predictive software solution - the Maritime Analytics Intelligence System (MANTIS) - to use ship location data to answer this call.

By monitoring and analysing ship movements throughout UK waters over time, Emu Analytics can identify evolving patterns of movement, leading to more predictable outcomes for proposed future wind farms. To aid data collection further, Emu Analytics are working with Ship Finder and the National Coastwatch Institute (NCI) to deploy automatic identification system (AIS) receivers around the UK coast. Though this type of work, geospatial data helps significantly de-risk maritime assets and supply chains that involve shipping routes by increasing predictability and forecasting. It thus also increases confidence in investors and holds the added benefit of doing so without unduly limiting or halting the development and reach of renewable energy sources.

2 **Emissions monitoring:** Emissions monitoring can collect data on a macro level –where large emissions are made, large clusters of traffic are also likely to be seen – but there are other means of gathering that kind of data, as seen in the above section. Instead, emissions monitoring is perhaps most useful on the micro level, that is, in understanding which individual vehicles and modes of transport are generating the largest emissions, and what manufacturers can do to mitigate or remove them altogether.

Aircraft represents a big contribution to emissions, with the aviation industry accounting for around 2% of total global greenhouse gas generation. Fortunately, it is an industry that also generates a huge volume of data, with modern aircraft collecting as many as 400,000 data points per flight.[23] This information, which, if shared and analysed correctly, could lead to rapid, and wide-reaching improvements in the long-term sustainability of aviation through the creation of more efficient routes and design of increasingly efficient aircraft.

Shipping accounts for around 10% of total transport emissions.[24] The decarbonisation of ports has been specifically highlighted by the European Commission as an essential opportunity for environmental gains. It stated that key to achieving them is the 'use of smart digital solutions and autonomous systems, as these optimise traffic flows and cargo handling in and around ports.'[25] With their key position in global supply chains, ports are uniquely positioned to monitor emissions and encourage the adoption of net zero strategies worldwide, a point raised in the Pavilion session 'Ports and Their Role in the Blue Economy'.

Case Study:
Enabling a better understanding of maritime activity

The AAC Clyde Space AIS data archive, dating back to 2009 with a constellation of Automatic Identification System (AIS) microsatellites continuously acquiring data, has revealed notable insights on maritime traffic trends with depleting Arctic Sea ice. In particular, it revealed the increase in Arctic shipping activity driven primarily by growth in maritime socio-economic activity in the region, with the most traffic between Arctic seaports. By understanding the changing nature and patterns of maritime activity, and the consequent environmental effects they are having, policymakers, route setters, ship designers, and more, are better equipped to ensure a better, more sustainable global shipping industry. Policymakers, for example, can identify ecological problem areas within their territorial waters caused by shipping, making adjustments to existing regulations while also pinpointing areas for increased investment in sustainable initiatives. In this way, geospatial data that primarily identifies vehicle locations holds the potential for further-ranging, systematic changes to an industry responsible for a significant proportion of the human carbon footprint.

23 Dr Hina Khan, 'The Future of Transport.' - (08:00)
24 Our World in Data based on International Energy Agency (IEA) and the international Council on Clean Transport (ICCT).
25 European Commission, Communication on a new approach for a sustainable blue economy in the EU, 17 May 2021, COM(2021) 240 Final

3 **Digitisation:** Digitisation links both route and emissions monitoring. It is through digitisation that networks stand the best chance of enabling frictionless transport routes that host low-to-zero emission vehicles. Harmonised and interoperable digitisation takes collected data and enables the building of a joined-up view of the world.

Take for example a digitised ticket machine, toll booth on a road, or even a shipping port. Each is able to collect real time data on usage, passenger and freight types, and frequency, at a lower cost than through having feet on the ground to do the same job. As this data is digitised and sorted upon collection, it becomes more readily shareable and comparable between the likes of the public and private sectors, as well as differing jurisdictions.

Underpinning all this is geospatial technology, as it enables analysts to pinpoint the temporal and location data of all traffic passing quickly and precisely through a certain point.

There remain constraints here, such as restrictions on the financial transaction information that can be shared. Digitisation does not mean that data can be automatically shared, and ethics, privacy and regulatory concerns must be considered at all times.

Geospatial data is the link identifier between objects, people, systems, and the environment. It exists in tiers, from a simple address, to timeseries data for a moving vehicle, to derivative geospatial data that uses timeseries data and applies techniques such as machine learning to generate further insight.

The need going forward is a greater ability to link the vast quantity of geospatial data with other datasets – for example, pollution, behaviour patterns, prices, weather, and more – to create system value, not simply competing transport operators. In linking the differing types of data, much broader, much more user-centric transport networks can be established, as competition becomes less about the quantity of fares received, and more about the quality and value of data a transport operator is able to offer to the wider ecosystem. A more user-centric system could run more services how we need them, rather than users accommodating to systems that were designed without the user in the centre. Rather than solely focusing on profit, a system could be designed with the aim of reducing living costs, and concentrating on the social mobility components of transport. There is recognition of this potential from the UK government, which has published a policy paper, Positioning the UK in the fast lane - Location data opportunities for better UK transport, in this area through its Geospatial Commission.

Achieving the necessary shift in mindset more widely requires the de-siloing of data, making it interoperable, and incentivising its sharing as a result. Former US Vice-President Al Gore described this approach as 'radical transparency' in his address to the Pavilion. For example, in the past, organisations such as intelligence agencies would have collected data in the dark and kept this data to themselves.

Reaching Net Zero has long been stymied by both a lack of transparency and accountability, and only open access to data can enable real action. With everything out in the open, climate action is made easier, even within a complex system like transport. In recognition of this, Innovate UK and the Geospatial Commission have partnered to launch the Transport Location Data Competition, which recognises the importance of location data to solve transport challenges and stimulate the rapid prototyping of many innovative geospatial solutions. It also recognises the need of focused finance to build the innovation to reduce net zero. In this chapter two case studies - Emu analytics and Dynamon - are from the competition winners and other interesting innovation can be found in the Transport Competition Brochure.

The most effective way to enable the requisite level of collaboration means building a data architecture that establishes trust, both between competing partners and with the public too. The FAIR Guiding Principles for data seek to serve this purpose; implementing them across transport operators, urban planners, vehicles manufacturers, and indeed any organisation with a vested interest with the more efficient transport of people and goods, is what will see increased resilience within transport networks. This resilience will allow user-centricity, and a more considered, unified means of ensuring the sustainability of all forms of future transport.

Connecting for
Positive Change.

Energy

- Building a greener energy infrastructure
- Locating energy assets
- Securing energy in all conditions
- The need for multidisciplinary activity

Innovate UK
KTN

Building a greener energy infrastructure

Energy systems play a critical role in mitigating climate change. The greater the shift from fossil fuels to greener, more sustainable energy sources, the closer the planet will get to meeting Net Zero.

On the demand side we can expect to see an ever-growing need for energy. Decarbonisation of transport and heating systems, for example, will significantly increase demand over the coming decades. Furthermore, the majority of the world's energy is currently supplied by high voltage electricity. This is only set to increase in the move to a carbon free economy, as electric vehicles, in particular, become more common. Security of supply therefore becomes paramount, as more and more human activity becomes intertwined with a stable electricity supply.

The caveat to this statement is that moving to a secure, carbon-free supply in a particular region must not simply shift the environmental impact to another. For example, more low carbon energy production requires more storage often in lithium batteries, which are themselves carbon intense in production, and can cause significant environmental damage as well as to communities living near the deposits. This further highlights the need for a systems-based approach (highlighted in Figure 1 of the IPCC WG2 report), which takes into consideration the entire supply chain of energy generation, storage, and use when developing energy infrastructure.[26]

What is often overlooked, however, is that energy systems are themselves susceptible to the impacts of climate change. Critical energy infrastructure is often weather dependent and is likely to become more so due to climate change, as extreme weather becomes increasingly frequent and more extreme. An increased proportion of renewables potentially means greater self-sufficiency as a nation but leaves a nation more exposed to fluctuations in weather in terms of the generation of this renewable energy. What this means is that any future renewable configurations of energy systems must be rigorously stress tested to ensure weather and climate resilience.

Increased demand for electricity puts greater strain on energy systems, already facing the growing challenge of coping with extreme weather events, themselves caused by humanity's ever-larger appetite for electricity. The question of whether adapting legacy infrastructure is enough to overcome this, or whether a more radical overhaul of energy systems is required is therefore a pertinent one. The answer to these challenges varies greatly depending on the existing (or otherwise) infrastructure of a nation, and it will most definitely rely on geospatial data.

26 See Fig 1 in the Summary for Policy makers

Locating energy assets

Of particular importance, geospatial data has the potential to uncover suitable sites for greener energy generation. A key tenet of the Paris Agreement and its ambition to keep global warming below a 1.5-degree temperature increase is putting an end to the use of fossil fuels. In order to do this, it is imperative that more large-scale renewable energy installations, particularly wind and solar farms, are built, as well as wider use of ground heat, hydro and wave power. However, there will always be locations more suited to particular types of renewable energy generators due to their geography, natural climates, weather, etc, so it makes sense that geospatial data is utilised to source the most efficient sites, saving time and money, and maximising energy generation.

Geospatial data at its heart provides information on location, which makes it perfect for digitalising the energy assets of a nation, both where they are in isolation and in relation to the rest of the network. By digitally mapping assets, it affords important operational data for cross-sector infrastructure, and enables the creation of a Digital Twin, that is, a near real time virtual model which can be tested in various scenarios and remodelled ad infinitum. It is the most cost effective, yet accurate means by which alterations to the overall structure of a network can be tested, as potential problems can be discovered before any physical work is undertaken.

Case Study:
Filling the greenhouse gas knowledge gaps

Climate TRACE is a global coalition of 50+ organisations built to collect and share greenhouse gas emissions from human activities to better facilitate climate action. Its emissions inventory is the world's first comprehensive accounting of such emissions based primarily on direct, independent observation. In doing so, it helps fill knowledge gaps in nations' emissions inventories. This empowers nations to further their sustainability initiatives and move towards more systems-based thinking and planning in their energy generation. Those nations previously lacking in this kind of geospatial data are often those with more fossil-fuel reliant energy infrastructure, as well as higher interaction with the impacts of climate change. It is therefore of significant benefit to them, and offers the chance to identify current issues, remediate against them, and build in greater resilience going forward. Climate TRACE is a good example of the collaboration required in de-siloing and sharing geospatial data, particularly with those for whom it has historically been limited.

Digital Twins are thus key to understanding planning issues around increased energy use and demand. Electric vehicles (EV) for example, are set to have an immense impact on the design of energy systems, as they will require wide rollout of supporting infrastructure. With a Digital Twin of a given region, town planners and energy systems technicians can begin to not only ask the questions around the implications of charging station placements, energy generation, and timing of peak use, they can begin to answer them too. A digital twin could help identify the pain points on the system under different scenarios and help direct policy and which aspects need to be more resilient. Stress testing in this way ensures much better preparedness of energy systems, and much greater cost-effectiveness and overall efficiency as a result. For example, creating a digital twin of the critical infrastructure networks, as has been achieved in the CReDo project, allows the planner to stress test, and improve climate adaptation and resilience across a system of systems.

This sentiment would not sound out of place in regard to either Built Environments and Cities, or Transport, which only serves to highlight how inextricably intertwined these topics are, and that a systems-based approach is the only viable solution. Working in silos is simply not an option if climate change is to be combatted meaningfully and effectively.

Case Study:
Using digital twins to identify the best interventions to increase resilience

CReDo is a climate change adaptation digital twin sponsored by UK Research and Innovation and Connected Places Catapult and is the pilot project for the National Digital Twin programme. CReDo brings data about assets across three infrastructure asset owners, Anglian Water, BT, and UK Power Networks together with future flooding scenarios into one digital twin of the infrastructure system. This cross-sector picture of the impact of extreme weather events on the infrastructure system can enable asset owners and regulators to better understand infrastructure interdependencies and identify the most effective, least cost, and lowest carbon impact interventions to increase resilience. Resources and recommendations to develop connected digital twins like CReDo are available on the Digital Twin Hub.

Securing energy in all conditions

The single biggest risk to energy generation capabilities is heat, specifically the increase in frequency and intensity of extreme temperature days. Temperature is a major factor that can cause compounded risks in transmission systems, which affects the whole supply chain of supply, network, and demand.

Wind droughts, that is, periods of low energy generation from turbines due to periods of settled weather are another big risk to an energy system more reliant on renewables. Wind dominates the renewables sector in the UK and is the fastest growing energy source therefore the implications for energy security are significant. Wind droughts are often associated with conditions that increase demand on the system, for example blocking highs result in low wind speed and high temperatures in summer and cold temperatures in winter, naturally with greater concern around the latter where heating demand will be greater.

To combat the effect of extreme weather, an initiative in the UK, Adverse weather scenarios and future electricity generation, involving the Met Office, National Infrastructure Commission, and The Committee on Climate Change has developed a set of adverse weather scenarios, such as long-duration wind droughts. These represent plausible 'alternative realities', capturing weather scenarios more extreme than those previously observed in the historical record, capturing the effect of climate change, and the impact these will have on supply and demand.

Another similar project led by the University of Bath, 'Mapping the Impacts and Visualisation of Risks of extreme weather on system operation' (MIVOR), allows analysts to add to its scenarios statistical models and maps of previous faults within the infrastructure network to identify areas of highest risk.

The adverse weather scenario data and insight from these projects combined with digital twin models will give future infrastructure developers the insight needed to test and enable greater resilience and longevity of energy sources.

Case Study:
Mapping extreme weather risks to energy

Mapping the Impacts and Visualisation of Risks of extreme weather on system operation (MIVOR) is an initiative that uses analytical and statistical modelling to estimate the impact of climate change on energy systems. It uses datasets from UK Climate Predictions (UKCP) to predict future weather situations to a high spatial resolution, and which areas of the UK National Grid will be impacted by higher demand along with how the grid will be affected by higher temperatures and winds. In obtaining this kind of geospatial intelligence, stakeholders within the UK energy sector are equipped to build much greater resilience into the energy network, while also facing up to present issues.

The need for multidisciplinary activity

The opportunity to create a more resilient energy infrastructure in all parts of the globe is evident. Whether upgrading existing energy infrastructure to better suit it to 21st Century needs, that is, removing fossil fuel dependency and ensuring renewable sources can withstand a changing climate, or establishing entirely new infrastructure from scratch, geospatial data holds the key in its ability to provide precise location information for modellers to then stress test hypotheses and possible solutions previously unthinkable, as seen with digital twins and the CReDo project, for example.

In addition to locating manmade assets, geospatial data also informs planners and policy experts of the effects nature is increasingly having on energy systems. This understanding is crucial, as humanity is in uncharted territory with regards to both the installations in operation for energy generation, and the conditions under which they operate. Knowing ahead of time under what circumstances infrastructure is likely to fail is essential to mitigating and swiftly remediating such issues.

The analysis of the geospatial data used in energy research and the practical implementation of its findings, however, must be multidisciplinary. It will require open collaboration between geospatial data collection teams, network engineers, climate scientists, mathematical modellers, infrastructure and material engineers and more to be able to provide the secure and robust energy systems that meet not only the required future quantities of energy, but also the timescale predicted. Once again, the FAIR principles of data come to the fore in making this aspiration a reality.

The future of energy supplies relies on acknowledgement that not only will life be affected, but that the infrastructure on which that life depends will also. It is through a systems-based approach that this challenge will be met, and the correct critical energy infrastructure put in place.

“Whether upgrading existing infrastructure to better suit it to 21st Century needs, or establishing entirely new infrastructure from scratch, geospatial data holds the key in its ability to provide precise location information for modellers to then stress test hypotheses and possible solutions.”

Connecting for
Positive Change.

Conclusion

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Innovate UK
KTN

The way forward...

“Geospatial intelligence is key business intelligence.”

To influence changes at the global level, it must first be understood what is happening within local communities. That is, the effect global warming is having on a smallholding in rural Botswana must be understood as much as its effect on New York City, and everywhere else in between. This is where geospatial data best shows its unique worth: never before have humans been afforded the opportunity to see every inch of the planet’s surface in such detail thanks to satellites. Observers can see in real time the damage wrought by increasingly frequent and intense weather patterns and events. They can see the receding of land suitable for agriculture, the encroachment of urban centres onto unique natural habitats, and more.

Geospatial data doesn’t end in space, however. Geospatial data from the likes of traffic cameras help visualise areas of greatest pollution and congestion on the roads, giving town planners the geospatial intelligence upon which they can make more informed decisions on new routes as well as improvements to existing networks. Add to this the geospatial intelligence gleaned from underground digital mapping of pipes and cables, providing construction firms and local authorities with a true picture of what lies beneath ground level before undertaking further work to avoid utility strikes, and thus reduce road congestion and the associated carbon emissions, for example. It soon becomes evident that the intelligence available from geospatial data is a critical tool in tackling climate change. It is from geospatial data that patterns emerge from which stakeholders can derive actionable insights and decisions that will make the greatest impact in the fight against climate change. This is the crossroads where geospatial intelligence becomes key business intelligence.

Underlying the unique opportunities afforded by geospatial data, of course, is collaboration. It is only through collaborative efforts that climate catastrophe will be averted. To achieve the level of collaboration required will often mean a radical shift in approach away from siloed, ‘shareholder value’, towards creating ‘system value’. It is through creating value for systems as a whole that resilience is instilled and deeper, more lasting positive change for the greatest number can occur.

There is no silver bullet that will rid Earth of the challenges caused by global warming. Instead, it is essential that those generating geospatial data are able to freely share it with those who analyse it so as to then share it with those who can put its findings into effect.

Those to whom this maxim applies are numerous and varied, working in often very disparate fields, meaning bringing would-be collaborators together has often proved difficult. The hope is, then, that this publication and associated podcast series will serve as a rallying cry, highlighting the very fact that fighting climate change requires more than just those loosely termed ‘climate scientists’; it is too big an issue for a single group to deal with, and certainly too important an issue to ignore.

Our changing climate is a complex system and complex systems can only be managed collectively – with experts in all areas collaborating to achieve goals that transcend their own specialisms. Geospatial data, as a link identifier, can serve as a common language between these groups with which to measure, understand, bring meaning to, and apply information about climate change – so that we can make more informed, targeted and effective decisions to protect our planet.

By incorporating geospatial data across all work to achieve Net Zero, and improving the quality, traceability and accessibility of this information, together we can harness the power of place to make the world a better place.

Who we are...

Innovate UK KTN exists to connect innovators with new partners and new opportunities beyond their existing thinking – accelerating ambitious ideas into real-world solutions.

We create diverse connections to drive positive change, and to establish a network of innovators so powerful its ideas will change the world. Innovate UK KTN is part of UK Research and Innovation (UKRI).

Our partners...

Our partners in the Space and Geospatial Virtual Pavilion for COP26 were:

Partner glossary

AAC Clyde Space: AAC Clyde Space are changing the economics of space data. We specialise in small satellite technologies and services that enable a growing number of commercial, government and educational organisations to access high-quality, timely data from space. Data is hugely important when it comes to sustainable space, from weather forecasting to precision farming to environmental monitoring, and is essential to improving our quality of life on Earth.

The Association for Geographic Information: The Association for Geographic Information (AGI) is the professional association for those working with geographic and location data. The AGI is the professional membership body for any organisation, public or private sector, bluechip, SME or start-up, and any individual with an interest in location data and in the applications, products and services that geospatial tools and technologies can provide to help address so many of today's global challenges. We support our members to build their professional networks, develop business opportunities, increase skills and access to training opportunities and focus on career and personal development. AGI is the conduit for the flow of geospatial ideas and capabilities and an ecosystem hub with the convening power and expertise to help organisations large and small realise the role, utility and value that a geographic perspective brings to their organisations and their customers.

AstroAgency: AstroAgency provides the space sector supply chain and new entrants to the industry with strategic marketing support; a unique combination of brand building techniques, space media coverage, technical guidance and market intelligence for identifying new revenue streams. Our international team has extensive practical experience of working within the commercial space sector and brings together technical knowledge and experience with our space marketing specialists. This unique approach, together with our connections, ensure that our clients thrive in the burgeoning newspace market. We have a passion for applying branding, communications and market analysis skills to space technology opportunities, and are driven by the belief that space applications bring a host of positive benefits to life on Earth. By amplifying our clients' positive messages to reach other sectors, investors, customers and the general public, we help them make a positive contribution to this goal, and grow their businesses at the same time.

BARSC: BARSC is a promotion platform for members companies and organisations from around the world who supply remote sensing data, technology, services and hardware to industries and governments. Our focus is on the commercial development of earth observation: we work to promote and educate prospective end-user communities not confuse them with industry jargon. Our membership includes single-person consultancies, early-days start-ups, multi-national, multi-billion dollar companies and government-backed organisations. We recognise that earth observation from space, aeroplanes or drones will play a fundamental role in the battle against climate change. Our members offer the ability to directly monitor change on a continent-wide scale or down to the millimetre. More than that, their insights stretch well beyond that which can be seen with the naked eye.

Partner glossary

ESA Space Solutions: The go-to place for great business ideas involving space in all areas of life. We're ready for your idea! Find funding & support.

ESRI UK: Esri is the global market leader in geographic information system (GIS) software and has been helping customers unlock the full potential of data since 1969. Today, Esri software is deployed in more than 350,000 organisations globally, including the world's largest cities and most national governments. Esri UK now has 3 different offices throughout the UK, in Aylesbury, Cambridge and Edinburgh, and our workforce is constantly expanding. We supply mapping and spatial analytics software for desktop, software as a service (SaaS) and enterprise applications, all designed to deliver location intelligence and meet digital transformation needs for organisations of all sizes. For over 50 years, we've been committed to the conservation of our planet and invested in solutions that help protect it and advocate for its care. Business and government leaders who need to understand the impacts of climate change rely on climate risk analytics and geographic information system (GIS) technology from Esri. Across almost all industry sectors, Esri UK customers are already taking action to repair the damage done to our world and develop more sustainable ways of working and living.

Geospatial Commission: The Geospatial Commission was established in 2018 as an independent, expert committee responsible for setting the UK's geospatial strategy and coordinating public sector geospatial activity. Its aim is to unlock the significant economic, social and environmental opportunities offered by location data and to boost the UK's global geospatial expertise. The Commission has a mandate and budget to drive and deliver changes by working in partnership with others. This means we: 1) Provide strategic oversight of the geospatial ecosystem in the UK, setting geospatial strategy, policy and standards. 2) Hold the budget for the public sector's largest investment in geospatial data. 3) Make targeted investments in data projects that accelerate innovation and adoption of geospatial data applications.

Geospatial World: With the vision of 'Making a Difference through Geospatial Knowledge in World Economy and Society', Geospatial World has been working on developing the geospatial industry for more than two decades. Through its consistent efforts in this direction, the company has earned international repute and credibility, and is known to be a geospatial technology evangelist. Geospatial World achieves its objectives by publishing content on geospatial technologies, trends, policies and applications by the Media Division of the Company.

GHG Sat: GHGSat is the global leader in high-resolution remote-sensing of greenhouse gas from space, an approach it pioneered, and provides unique emissions data and intelligence to businesses, governments, regulators, and investors worldwide, to optimise their performance and uphold environmental standards.

Group on Earth Observations: GEO is an intergovernmental partnership working to improve the availability, access and use of open Earth observations, including satellite imagery, remote sensing and in situ data, to impact policy and decision making in a wide range of sectors.

Innovate UK: Innovate UK drives productivity and economic growth by supporting businesses to develop and realise the potential of new ideas, including those from the UK's world-class research base. They connect businesses to the partners, customers and investors that can help them turn these ideas into commercially successful products and services, and business growth.

Insta Associates: Insta Associates is a retained innovation advisory platform for leading organisations. We provide our clients with strategic insights on emerging markets, connectivity with frontier innovators and actionable business opportunities. We help our clients to unlock new value by connecting with frontier companies and technologies. We work with them at the interface of private - public - academic collaboration to forge highly valuable partnerships for transformative growth.

Location Data Scotland: Location Data Scotland is an inclusive geospatial community across Scotland, established to unlock the value in location data. We have been created to leverage location data as an enabler of innovation and to create greater efficiency in the products and services delivered and utilised by organisations and the public sector in Scotland. We can help connect, inform and facilitate collaboration between industry, academia, public and third sector, across multiple sectors, to drive innovation, unlock skills and enable economic growth. Facilitated by our independent cluster building experts, Optimat, we will work to bring together an inclusive community of entrepreneurs, industry, third sector, academia and public sector to collaborate, drive innovation, create opportunities and efficiencies and unlock the value in location data across multiple industries and sectors.

Open Geospatial Consortium: The OGC is a worldwide community committed to improving access to geospatial, or location information. We connect people, communities, and technology to solve global challenges and address everyday needs. The organisation represents over 500 businesses, government agencies, research organisations, and universities united with a desire to make location information FAIR – Findable, Accessible, Interoperable, and Reusable. Our community creates free, publicly available geospatial standards that enable new technologies. OGC also manages an agile and collaborative research & development process - the OGC Innovation Program - that anticipates and solves real-world geospatial challenges experienced by our members.

Ordnance Survey: Ordnance Survey provides national mapping services for Great Britain and is a world-leading geospatial organisation. Our location data and expertise has helped governments make smarter decisions, businesses gain valuable data insight, and everyone experience the world outside for over 225 years. From laptops to hilltops, blue lights to streetlights and congestion to relaxation – our location expertise shows the world how to get to a better place.

Satellite Applications Catapult: The Satellite Applications Catapult is a unique innovation and technology company which boosts UK productivity by helping organisations harness the power of satellite-based services. We work with businesses of all sizes to realise their potential from space infrastructure and its applications. By connecting industry and academia, we get new research off the ground and into the market more quickly. We help organisations make use of and benefit from satellite technologies, bringing together multi-disciplinary teams to generate ideas and solutions in an open innovation environment. Through our work we aim to support UK industry to capture a 10% share of the predicted £400Bn global space market by 2030.

Satellite Vu: In 2023 Satellite Vu will launch the world's first commercial constellation of high-resolution thermal imaging satellites. Constructed in the UK, the constellation will be capable of resolving building level measurements providing an accurate determination of relative temperature, at multiple times of day or night. This unique technology will help us better understand change and activity within the built and surrounding natural environment that traditional visible wavelength imagery will not detect. This imagery will help identify buildings that are poorly insulated and are wasting heat, identify potential sites for energy recovery & provide invaluable data for water resource monitoring.

Scottish Space Leadership Council (SSLC): The SSLC acts as a co-ordinating gateway to enable and promote the Scottish space sector as part of the wider UK proposition, focusing on tangible outcomes. It is a collegiate forum that brings together key sector stakeholders across industry, academia and government on a regular basis via quarterly meetings, as well as working group meetings and ad hoc work streams. The SSLC is an inclusive and diverse community that is open to any organisation with a role to play in the development of the Scottish space sector, providing a central hub to coordinate activity across the regional "meta-cluster" and sectoral value chain.

Partner glossary

Space4Climate: Space4Climate is a UK community building a seamless supply chain of trusted climate data from space, bringing together academic, public sector and private sector expertise. The group is chaired by the UK Space Agency. We maximise the opportunities created by existing Earth observation satellites and those in production connecting those designing and building the spacecraft right through to those who will be using the data to help us all to take climate action. The power of Space4Climate, which is a neutral organisation, is that it brings all these people together to cross-fertilise ideas and create collaborations. We have close working links to Government ministries and departments, including BEIS, Defra and DIT. We are currently hosted by the National Centre for Earth Observation (NCEO) and as an organisation we legally come under the University of Reading. Space4Climate acts as a neutral broker connecting UK producers and global users of trusted Earth observation, weather and positioning data and actionable space-enabled climate analytics and services.

Space Academic Network (SPAN): The Space Academic Network (SPAN) provides a voice for UK academic space research. It comprises 43 of the leading space universities and over 200 participating scientists and engineers in its working groups. SPAN has been highlighting the need for new investment in space research and technology to maintain UK leadership and excellence in science; to support and strengthen the space sector; and to provide opportunities for the next generation of space leaders.

Sparkgeo: At Sparkgeo, we provide geospatial expertise to companies. Our obsessive focus on geospatial technology makes us somewhat unique. In fact, most of our work has been with other technology companies who look to us as leaders in this field, combining our team's expertise with their in-house team. We're curious, listen carefully, are platform-agnostic, and afford critical value to our clients.

Spatial Finance Initiative: The Spatial Finance Initiative, which is now part of CGFI, has been established by the Alan Turing Institute, Satellite Applications Catapult, and the Oxford Sustainable Finance Programme to bring together research capabilities in space, data science as well as financial services and make them greater than the sum of their parts. The Initiative was set up to mainstream geospatial capabilities into global financial decision-making and promote the development of new spatial finance applications.

UK Research and Innovation (UKRI): UKRI and its councils invest in world-changing research and innovation to understand, tackle and mitigate the effects of climate change and inform climate policy. Our aim is to invest in research and innovation which enable the UK to reach net zero by 2050. Our vision is for an outstanding research and innovation system in the UK that gives everyone the opportunity to contribute and to benefit, enriching lives locally, nationally and internationally. Research and innovation enriches and improves our lives and increases prosperity by creating knowledge that enables us to understand ourselves and the world around us. This also empowers us to focus on the many challenges we face as individuals and as communities, nationally and globally.

UK Space Agency: We, the UK Space Agency, provide technical advice on government's National Space Strategy, and guide the UK space sector to deliver government's vision. We design and deliver programmes that implement government's Space Strategy, including as a sponsor of national capabilities and an early-stage investor in space research and development. We promote the UK space sector's interests and achievements, make connections to join up industry and academia, and represent the UK in international space programmes. The UK Space Agency's work on COP26 is guided by the National Space Strategy which sets the strategic direction of our work on climate. Goal 5 of the NSS commits HMG to "Use space to deliver for UK citizens and the world". In alignment with this goal, our COP26 work package sets out a broad range of initiatives that seeks to deliver against these goals by supporting climate change mitigation and adaptation both for the UK as well as globally by using our world-leading scientific and private sector expertise.

UKspace: UKspace is the trade association of the British space industry, representing and promoting space to government and other key stakeholders nationally and internationally. As a government priority sector, it has never been a better time to be a member of UKspace and a key and valued part of the UK space community.

University of Oxford: The Oxford Space Initiative is the social sciences research group on space commerce and governance at the University of Oxford. Our team unites researchers and practitioners from economic sociology, technology and innovation management, governance and law, international relations, major program management, strategy and leadership. We conduct cutting edge research on the developments in the global space sector. We look for collaborators, sponsors, and partners for our research and impact activities.

World Geospatial Industry Council (WGIC): The World Geospatial Industry Council (WGIC) is a global not-for-profit trade association of private sector companies working in the geospatial sector. WGIC works to strengthen the contribution of the geospatial industry to society and the global economy; undertakes policy studies to inform the industry, public authorities, and relevant stakeholders; and creates business opportunities for the geospatial sector. Through its activities, WGIC facilitates knowledge exchange within the industry and represents the business interests of the geospatial industry. Currently, WGIC focuses on climate change and its impact on the thematic areas of disaster resilience, energy transition, and resilient infrastructure. For this, WGIC works in close collaboration with global organisations, including The European Union Agency for the Space Programme (EUSPA), The Group on Earth Observations (GEO), The International Telecommunications Union (ITU), The Open Geospatial Consortium (OGC), The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM), and The World Federation of Engineering Organisations (WFEO).

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