SEE A RESILIENT NATION

How location data can help safeguard against natural and human threats

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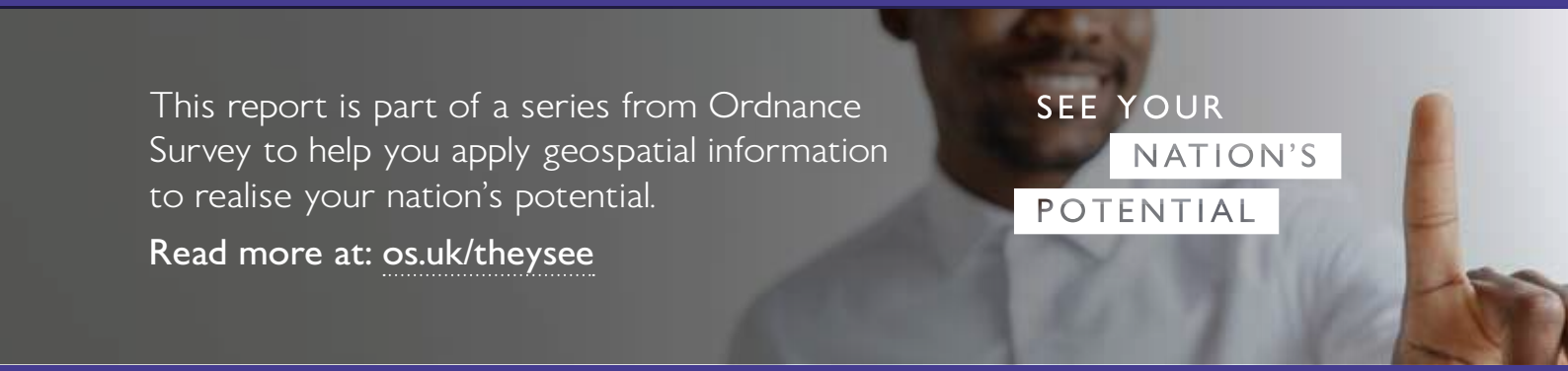

This report is part of a series from Ordnance Survey to help you apply geospatial information to realise your nation's potential.

Read more at: os.uk/theysee

INTRODUCTION

What is resilience?

Resilience is how we secure not only our current environments, but also those of our future. Creating resilience for a city or nation involves establishing systems and infrastructure that can withstand impacts from unprecedented events, environmental hazards, and human actions, as well as preparing an effective response plan to such incidents that will mitigate and minimise any ongoing consequences.

There are many types of impacts against which resilience is required. These include the effects of climate change and natural disasters; human aspects of terrorism, security of lives, conflict, and war; and economic implications of food security, supply chain stability, critical resources, and infrastructure.

In each case, the need for resilience exists on national, regional, city, or specific local levels, with structures in place required to safeguard against and respond to issues as soon as they arise. To enact and establish resilience across such diverse geographical entities and interests necessitates good communication and collaboration between various actors.

Data is the key for stakeholders to communicate and collaborate. Resilience must be built upon measurable data and consistent, accurate and authoritative information about where an issue is happening – providing a common operating picture, which offers understanding of not only the issues at local, regional or national levels, but also how solving one particular issue might affect and impact on another.

This interconnectedness of impacts has made resilience a key priority on many government agendas, including the push towards climate action and aiming for net zero. The climactic changes occurring across the planet have consequences on everything from food and water availability to re-homing individuals affected by more frequent and intense extreme weather events, to greater fluctuations in global financial markets, and more. What on the surface may look like a meteorological event actually goes far beyond such narrowly defined boundaries, and it is the abundance of data available that informs us of this.

The COVID-19 pandemic has also served to highlight further the need for greater resilience in our systems and infrastructure, both locally and globally. Not only is there demand for resilience in existing healthcare systems to cope with widespread health emergencies quickly and efficiently, but also to better prepare against future pandemics which may be of a different nature, and their economic and societal consequences.

Geospatial data as a tool for resilience

When it comes to tools that help build resilience, geospatial data is one of the most useful assets at our disposal. Geospatial data can provide the context to the 'on the ground' picture surrounding an event, with high accuracy and often near-real time currency. Combined with sensor data or information from those involves in a response, it can provide a complete picture to analyse and make better, faster decisions.

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What is geospatial data?

'Geospatial data', also referred to as 'geospatial information', or 'location data', is information about location. Geographers and cartographers have worked with geospatial data for centuries, plotting maps and charts to represent the world around us.

In the 21st century, digital geospatial data is generated constantly, from locations derived from our mobile connections to remote sensing of the Earth's surface from space to global navigation satellite systems (GNSS) like GPS.

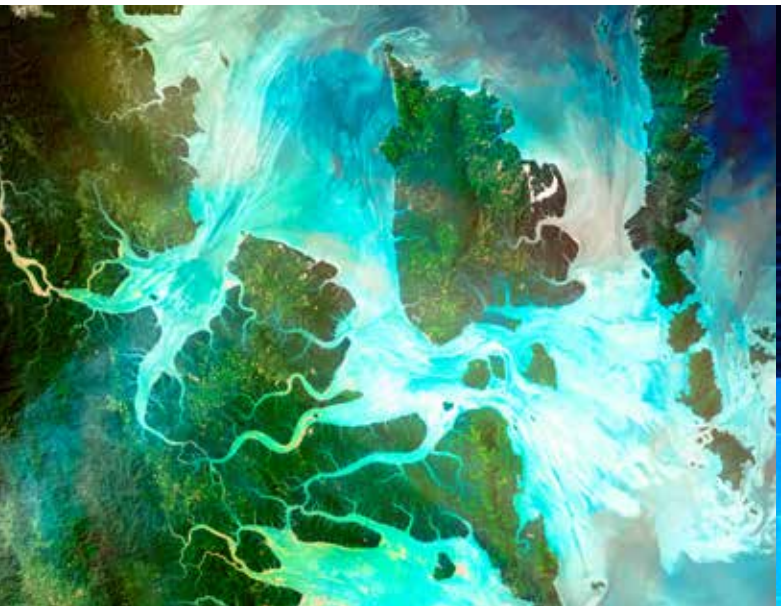
Geospatial data serves an important role in linking different data sets that would be otherwise unconnected, through their shared location and place. A 'spatially-enabled' society is one that benefits from a wide array of spatial data and services[1].

Enhancing and linking other data-driven initiatives, geospatial data is a critical enabler for nations seeking to grow their economies, drive sustainable development, support evidence-based decision making and policy setting, and enable new and innovative uses of government data to solve problems and provide new services.

Every country is at a different stage of implementation in their approach to managing geospatial information. 'Geospatial readiness' is a term used to describe the level of sophistication that a country has in its use of geospatial data and technology, and the value derived from it. A geospatial readiness assessment is a tool that can help organisations objectively understand how mature their geospatial capabilities are.

Geospatial data provides the context for stakeholders of every description, from emergency responders to city planners, app developers and beyond; ensuring they are afforded a common operating picture acting as a single point of truth using the common denominator, location. In this way, geospatial datasets are actionable in a way few others are, and so become key to protecting people, assets, the economy, and the planet.

1. https://www.fig.net/resources/publications/figpub/pub58/figpub58.pdf



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Challenges for governments

The primary challenge faced by governments and public sector organisations looking to build resilience in their communities is the accessibility and effective use of data created by multiple stakeholders, governments departments and the private sector.

Due to data sensitivities within both the public and private sector (particularly data that holds information on critical national infrastructure and personal data), it is not always widely shared for the purposes of resilience. However, with new advances in technology this information - underpinned and integrated with geospatial data - can be shared within secure data sharing platforms under strict, permission based access controls, enabling a common operating picture and ultimately setting a framework for collaboration and interoperability. These advances offer an opportunity to better establish a common operating picture that is essential for systematic mapping and modelling and contingency planning tools, improving response times and crucially, saving lives.

Better transport networks, increased mobility and optimised emergency services are examples by which cross-agency collaboration and data sharing can bolster a city's resilience. Aggregation of data between traffic and transport control centres, police forces, local municipalities and other agencies can give a complete picture of the current state and usage of public services, allowing capacity to be increased or decreased in line with day-to-day demand, or for emergency aid to be provided following a sudden event.

By sharing data between multiple organisations to a common standard, facilitated through governing policy and combined with supporting technology infrastructure, authorities are better able to achieve:

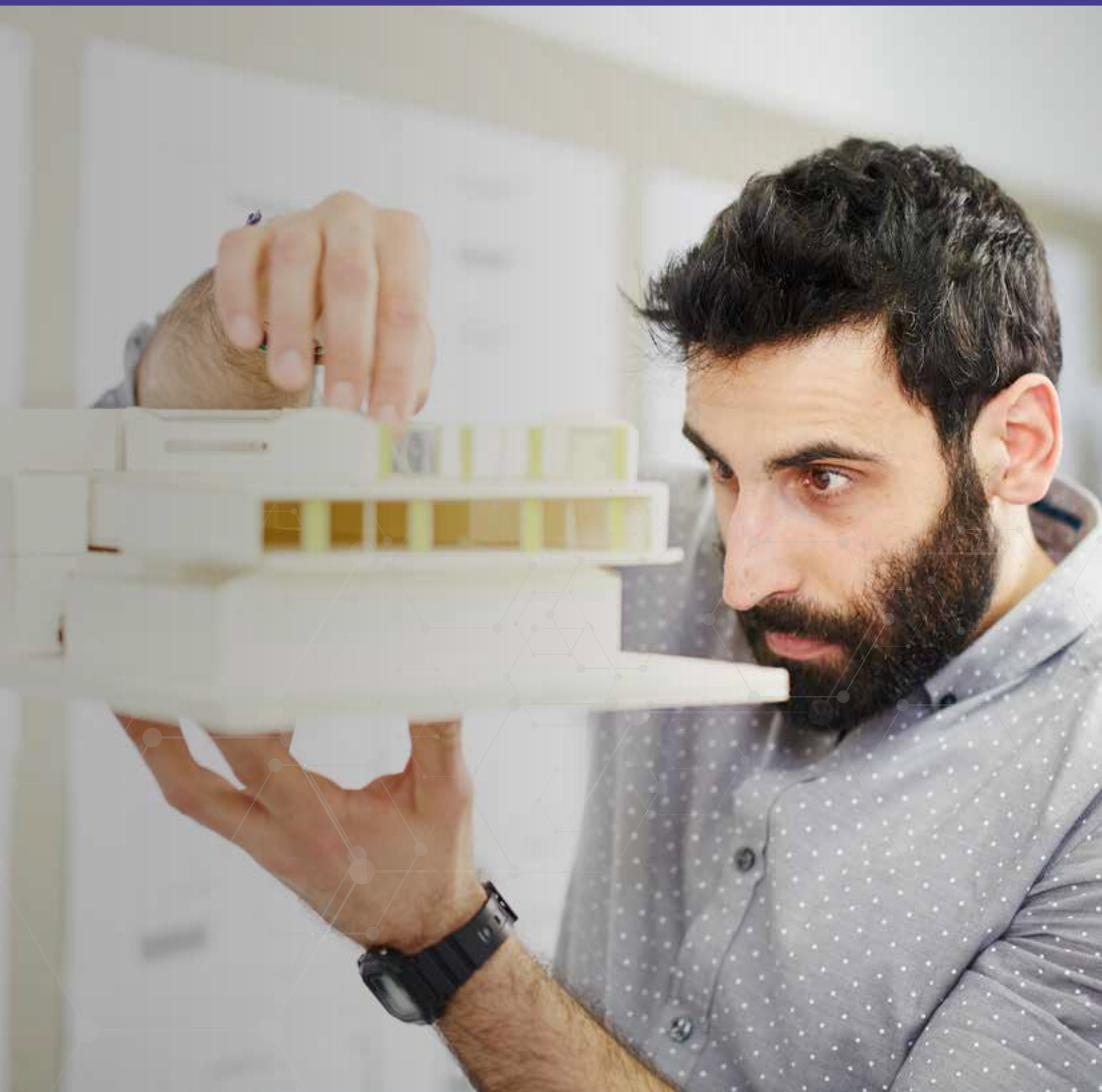
- **Cross-organisation analysis, problem solving and data-driven decision making**
- **Cost-effective, vendor-neutral systems**
- **Standards-based interfaces, ending the need for complex integration**
- **Risk reduction and effective management of data**

Location is often the only data field that the multiple datasets from different agencies have in common. Location data therefore becomes the golden thread or shared framework to bring these datasets together in a meaningful way. In addition to technically or physically bringing the datasets together, a mindset or culture change is frequently required to kickstart data sharing across departments or agencies. Often focusing on a key project or outcome, such as improving resilience, will attain buy-in from stakeholders and encourage them to see the transformative value of sharing data.

It is clear that better synchronicity between those who have the data available and those who need it, either for planning or response, will enable better decision making. It is important to have a common operating picture which acts as an authoritative single lens of location truth, and serves as an open framework through which data about place can be rapidly and unambiguously shared, and combined with data from disparate sources.

Explore the capabilities of geospatial data to secure a more resilient future for your nation.

2 PREPARATION



Equipping your community against major threats

Prevention is better than cure, and the mark of a truly resilient community is one that is prepared and equipped to deal with eventualities before they occur, rather than developing a strategy in the midst of a disaster. Resilience by definition is being able to withstand pressures with little to no negative change. Therefore, creating resilience within communities requires significant preparation.

Authorities must examine the threats faced by relevant communities in order to establish the priority areas to address in planning for major events, and the ways in which geospatial data can assist in mitigating against them.

Environmental Threats

As extreme weather events become more frequent and intense globally due to the effects of climate change, a greater proportion of people are put at increased risk. Integrated location data offers a mechanism to support the mitigation of these events, and the impact on the population.

An example of this is the utilisation of place-based environmental data to predict flooding – a weather event particularly noted for its increased frequency through climate change[2]. During a flooding incident, situational awareness is central to informing the response of the emergency services. Geospatial data – in the form of address and building outline information – contributes to a series of tools and integrated datasets used to build models and predict the timing, extent, and depth of flooding.

Such tools combine climate and rainfall data with information from sensors, on river or sea levels, and local topography, to provide early warnings about floods that might occur up to several days after the rain has stopped. For example, heavy rainfall in upland areas which can take several days to travel through a catchment into the lower reaches of a river.

Precise forewarning of environmental threats like flooding gives members of the public, businesses, and emergency services time, which can be the most important element for survival during an event. This can be time to defend themselves and their property, prepare contingencies, or simply evacuate. The more data that is collected on environmental threats, the better we can understand and predict them, and therefore the more time we can give people facing them.

More widely, tackling the impacts of climate change will require better information and clear evaluation of the risks associated with mitigation and adaptation activities. Natural disasters generate significant economic risk as well as risk to life and environment, and create major budget volatility for any countries impacted. Even countries with existing robust resilience systems can still be highly exposed to the economic and fiscal shocks caused by major disasters. Financial resilience for vulnerable countries facing climate change risks is something which the World Bank has considered for several years through the Disaster Risk Financing and Insurance Program (DRFIP). Key to assessing the disaster risk and evaluating impact is location information. The better the information the clearer the actual risk and the more accurately authorities can judge the effectiveness of climate mitigation measures and economic impact.

2. United Nations Environment Programme, 'How climate change is making record-breaking floods the new normal.' - https://www.unep.org/news-and-stories/story/how-climate-change-making-record-breaking-floods-new-normal

CASE STUDY

Building a new flood risk map

Published in October 2020, the Welsh Government's National Strategy for Flood and Coastal Erosion Risk Management in Wales sets out the long-term policies for managing flooding. It includes the measures which will be taken over the next decade by organisations including local authorities and water companies to improve how to plan, prepare and adapt to climate change in Wales over the coming century.

As part of that effort, authorities worked with OS' geospatial data to develop a new web service that provides flood risk information using a postal code. The Check Your Flood Risk by Postcode Service provides a report based on an address, making it easier for the people of Wales to find out the level of flood risk from rivers, the sea and surface water at their property or a property they're looking to move to.

Security Threats

Threats to security come in the form of both physical threats – for example, terrorist actions, conflict areas, violent protest – and virtual ones, specifically cyber threats. In each instance, knowing the location and potential spread of threats is built upon geospatial data.

Physical threats can be towards specific events, such as major sporting occasions like the Olympics, music festivals, or head of state visits. They can also be more general, such as underlying terrorist threats towards nations, buildings, groups of people.

Delivering major events and protecting the public daily requires highly informed operational centres which can coordinate the disparate agencies and interests contracted under their particular remits. Time and location are the essential data in every instance, with security staff on the ground needing to know detailed layout of the areas they are protecting; specifically, entry and exits, safety equipment, travelling times between points, and more.

OS has worked with major events including the Olympic Games in London and Rio de Janeiro to generate highly accurate cartographic products of the event areas to identify high risk areas for planning and prevention, as well as offering expert geospatial advice and support to ensure uniformity and correct application of data. As a result, the event organisers were in much stronger positions to support the safe and secure delivery of the Olympic Games.

Cyber threat mitigation can also be supported using geospatial data with details such as network, device, and geographic location integrated to provide cybersecurity experts with mappable and traceable physical locations that correspond to activity in the digital sphere. This can arms authorities to track cyber threats more effectively before they develop. Geospatial data can also be preventative, for example establishing geographical boundaries for the use of secure equipment or data, so-called 'geofencing'.

CASE STUDY

Safe and secure Olympic Games

Maps are a vital tool in the security planning for major events. Ahead of the 2016 Rio Olympics, the Brazilian Army recognised the need to adapt their existing, large scale map production system to incorporate small and mid-scale geospatial data, to better aid a precise and coordinated response. Ordnance Survey provided the experience and expertise needed to introduce geospatial software and hardware tools within the Brazilian Army Geographic Service production system through a bespoke map generalisation training programme.

Ahead of the 2012 games, The Olympic Mapping Portal was developed by the London Metropolitan Police for the London 2012 Olympic and Paralympic Games to ensure the safety and security of citizens during the event. The portal provided an efficient and secure way to view and share mapping and associated intelligence throughout the Games. Prior to London 2012, the Metropolitan Police used different GIS to supply mapping and associated data to its stakeholders. Information was maintained in separate databases and the different systems did not link together. To enable a common operational picture for both the police and external users, a system providing a single, definitive source of all Olympic data was created and used throughout the event.

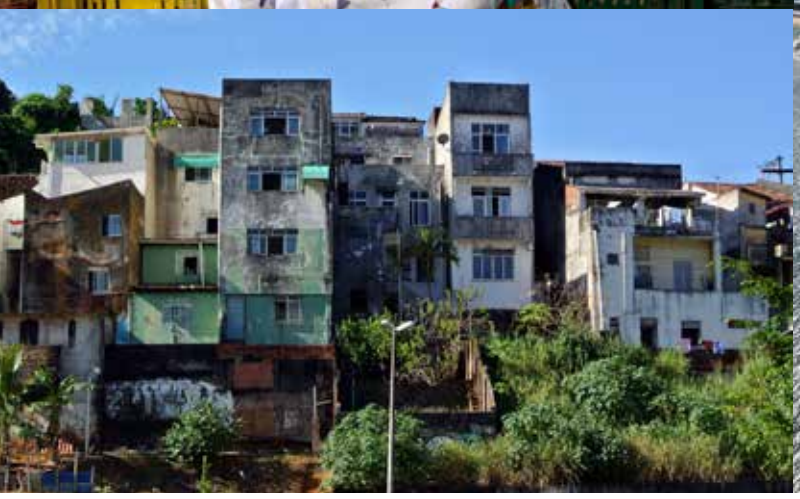
CASE STUDY

Building and protecting a safer community in Salvador

The city of Salvador has its own unique challenges, and OS partnered with local authorities to determine how current city databases could be leveraged and integrated to support further analysis and planning for urban resilience. To understand the stresses affecting Salvador, the team reviewed physical geographic factors including landslides, and socio-economic factors such as crime and social inequality.

Looking to improve public spaces, reduce crime and make community areas safer, Salvador analysed geographic information and demographic data to determine the optimal position for new street lighting and outdoor gyms. This played a big role in bringing the community together and reducing crime rates.

By knowing where certain activity is occurring, who is impacted and what the influencing factors are, Salvador can focus efforts on developing targeted solutions. The outcomes of OS's work with Salvador has resulted in a commitment to developing policy and establishing good data governance practices, to enable powerful data-driven decisions when it comes to implementing its new Resilience Strategy.



Healthcare Resilience

The COVID-19 pandemic has brought the need for resilience in healthcare provisioning and planning into sharp focus, to ensure people can not only access the services they need quickly, but that also they can be reached by the emergency services and receive care or testing equipment in good time to prevent further spreading of the disease.

Geospatial data contributes to an overall more resilient, healthier population, as health authorities can better match health services to the people that need them most and locate them to ensure they are readily available for the maximum population size.

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CASE STUDY

OS data and services support NHS and local authorities in COVID-19 response

Geospatial data is routinely used by local authorities as part of the analytical work informing policymaking and operations across Great Britain. In 2020, the London borough of Tower Hamlets were closely monitoring coronavirus cases data from Public Health England, integrating location data in this assessment to ensure they could quickly identify statistical hot-spots or spatial clusters of confirmed cases. Location data also acted as a foundation for incorporating additional data such property types, helping the council to better understand some of the inequalities that are associated with higher prevalence of COVID-19 such as deprivation or residents who live in social housing.

Having real-time insight on how the pandemic is progressing within the borough means the council have an early alert if cases are rising and can plan accordingly, prioritising the most vulnerable in the population.

Not long after the coronavirus pandemic began, OS also began working with the UK National Health Service (NHS) in support in their delivery of COVID-19 home testing kits as part of the government's national testing strategy.

With a national demand for testing kits, NHS Digital required trusted and accurate addressing data to support their operations. Using OS data, the NHS systems could ensure fast and precise delivery of tests to those who needed it during periods of high demands. The OS Places API created was being used to capture and verify over one million addresses each day.

Further harm to the NHS' chronically ill patients was a major risk of COVID-19, and vulnerable people were advised to shield and avoid public places wherever possible. To reduce patients' risk of exposure, the NHS had to pivot from giving care in hospital and instead offer a safe and accessible mobile medical support and blood work. The medical team adapted a van equipped as a mobile vaccination unit though still needed suitable places to park the mobile unit, however there were many complex parameters needed to find suitable locations. OS extensive datasets on road networks, car parks, and public facilities like toilets allowed the team to find optimal spaces for delivering mobile care to patients, but integrating these datasets with anonymised patient addresses.

Building smarter: fuelling the data economy

Globally, governments recognise that authoritative geospatial information is part of the national infrastructure, and that much of the development, oversight, and ownership rests with government. This requires that governments invest in their geospatial information capability to serve the public sector, as well as ensure their data is accessible and exploitable by partners and private companies. In so doing, they can deliver returns on their investments in geospatial information whilst laying the building blocks for a digital and more resilient economy that can bounce back faster from the fiscal impact of threats.

In 2017, the UK Government announced the formation of a new Geospatial Commission to help maximise the value of all geospatial information held by the government. One goal was to expand the availability of geospatial data to small businesses, particularly the types of innovative start-ups that will deliver as yet unimaginable technologies that will shape the way we live.

Many exciting technological breakthroughs, such as connected and autonomous vehicles (CAVs), will be heavily dependent on fundamental geospatial information. To navigate their way through city streets, self-driving vehicles will need to be able to access and analyse huge volumes of data on roads, buildings, street furniture and the transport network.

As well as helping to launch many modern digital services, geospatial information can also be used to upgrade and improve traditional industries. For example, utility operators use geospatial information systems (GIS) to determine the optimal location for smart grid components such as smart meters, sensors, and cell relays. A GIS can also help identify vulnerabilities, weigh asset investments, and gauge customer responses to a smart grid implementation[3].

3. 3 ESRI, GIS for Smart Grid, 2012

Designing infrastructure with resilience in mind

Currently, over 50% of the Earth's population live in urban areas, with this projected to rise to a figure of 70% by 2030[4]. Coping with such an increase must be a proactive decision by urban governments and authorities, and not merely reactive. If urban environments provide for their citizens ad hoc only, they run the risk of catering to citizens' need inefficiently, or not at all, leaving vast numbers of individuals without the necessities for survival.

Proactively planning for a shifting, growing population first involves understanding current assets and their capabilities for citizens. Knowing this allows a range of stakeholders and planners to make better-informed decisions as to what does and does not work for the specific populace. Armed with this intelligence, it is a step towards developing more capable, more resilient urban environments.

4. United Nations Department of Economic and Social Affairs, 'World Urbanization Prospects: The 2018 Revision.' - https://www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.html

The assets that need to be located and understood with accuracy include many ubiquitous in urban environments, including:

- Gas pipes
- Electricity grids
- Internet and telecommunications cables and infrastructure
- Road infrastructure
- Emergency response locations (e.g., ambulance stations, fire stations)
- Water pipes
- Sewage pipes
- Educational and medical facilities
- And more

The more layers of infrastructure policymakers and local authorities in urban environments can see, the better the picture of interconnectedness and thus potential weaknesses or opportunities for resilience they will have.

In the UK, the Geospatial Commission is building a digital map of underground pipes and cables that will revolutionise construction and development in the UK – the National Underground Asset Register. Accidental utility strikes cost the UK economy £2.4 billion a year. Currently there is no comprehensive platform in the UK that allows consistent access to data related to underground assets. Each utility holds data relating to their assets but the means of accessing this data and in what format is inconsistent because of differing software systems and different ways of capturing and storing data. Once operational, NUAR is expected to deliver around £350 million per year in benefits by avoiding accidental asset strikes, improving the efficiency of works and enabling better data sharing. Atkins, leading on the development will use its supply chain, consisting of ISpatial, Ordnance Survey, Geoplace, Connected Places Catapult and EY, to help deliver this phase of work.

CASE STUDY

Using AI to map African cities to improve infrastructure at low cost

OS, the International Growth Centre (IGC) and the Commonwealth Association of Architects (CAA) piloted the creation of an automated digital base map of Lusaka, Zambia to tackle the challenges associated with urban growth, and the availability of accurate and up-to-date data for creating well-planned and managed cities.

The Ministry of Local Government was looking to promote prosperous and inclusive urban settlements and ensure Zambia's towns and cities are resilient to support economic growth through better understanding of the city's informal settlements.

Using aerial imagery provided by the Zambia Survey Department in the Ministry of Lands and Natural Resources, OS utilised its advanced automated process to generate a new base map using artificial intelligence across 420km^2 of Lusaka.

This innovative technique is a rapid, accurate and cost-effective way to generate a detailed digital map that has a multitude of use cases, including the design and management of critical infrastructure services, land use planning, transport planning, land tenure, ownership, and administration together with the integration of future census data. Computers are taught what to look for in images using training data; the technology then automatically creates mapping quickly and accurately.

OS mapping data helps identify informal settlements, population and density, the number of built structures, the location of transport infrastructure surrounding the formal and informal neighbourhoods, as well as access to electricity, sanitation facilities and clean water.

This enables the Ministry to better target investment in critical infrastructure and services, upgrading informal settlements to provide for the most vulnerable residents. It also assists in better planning for urban expansion, which reduces the overall cost of infrastructure investment, limits informality, and enables more resilient and sustainable urban futures.

Food Security

One of the biggest challenges that climate change poses is its potential to disrupt agriculture and threaten food security.

At the same time as the climate emergency, many regions such as Africa are experiencing a population explosion. Food production in Africa and around the globe needs to dramatically increase while the conditions for growing that food are becoming more unpredictable. Geospatial data, tools, and techniques have an important role to play in ensuring food security. Geographic Information Systems (GIS) in agriculture can help farmers to achieve increased production and reduced costs by enabling better management of land resources, thereby increasing resiliency of areas most vulnerable to the effects of climate change[5].

New technology is helping to usher in a new era of farming known as precision agriculture. Geospatial data and software underpin precision agriculture, which is highly dependent on detailed digital maps and Global Navigation Satellite Systems (GNSS) like GPS.

5. https://www.geospatialworld.net/blogs/gis-in-agriculture/

GIS software can help visualise and understand how different variables, like soil type, wind direction, and rainfall are affecting yield, and provide analysis on how to increase it. Using sensors, drones, and software analysis, farmers are increasing their yields by harnessing highly accurate geospatial data to be more precise with their interventions[6].

Precision agriculture, underpinned by GIS, can help:

- **Increase crop yield by 11%**
- **Reduce herbicide by 15%**
- **Reduce fossil fuel usage by 16%**
- **Reduce water usage by 21%**

Climate-related risks, including increased extreme weather events, are also a significant threat to food security as they can increase the risk of crop failure. Extreme weather events like heat waves, floods, and intense rain are increasing in intensity, frequency, and severity across many parts of Africa due to climate change[7].

Geospatial tools can help your nation manage this increased risk and predict crop failure and drought. Digital base maps can now be built quickly and cheaply using automation and satellite imagery, with Earth observation data collected over many years providing information on land use, water availability, and soil type to give you analytic and predictive power to boost your food security.

Through greater understanding of our changing planet, and the interconnected cause and effects climate change has on differing environments and peoples, we are best equipped to prevent and mitigate its worst consequences on food security, ensuring resilience is baked into every facet of agriculture and its onward supply chains.

6. https://www.croplife.com/precision/study-shows-precision-agriculture-improves-environmental-stewardship-while-increasing-yields/
7. https://www.downtoearth.org.in/news/africa/extreme-weather-events-increasing-in-intensity-in-africa-greenpeace-report-74184

3

RESPONSE

Ensuring quick and effective action during an emergency

Responses to emergencies are more than simply reactive actions. To deliver the fastest, most effective responses takes planning long before those responses are required. While it may not be possible to account for every scenario, creating enough resilience within emergency response planning means it is a matter of adapting existing strategies to countering the unexpected, rather than fighting from a standing start.

Police, fire and ambulance services, local authorities, government agencies and armed forces all need to work together in any disaster scenario, coordinating on answers to vital questions: Can we pinpoint the worst hit areas? How many people are affected? Where are the emergency services located and where will they be directed to? How will they get there quickly? Is the route free of roadworks? Where are hospital beds locally? How many beds are available further afield? How many elderly people will require assistance? Where is protective equipment held? How quickly can it be distributed? Where can we refuel our emergency vehicles?

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Geography is key to answering all these points.

Particularly at times of crisis, it is imperative that the correct information is available immediately in a shareable manner to enable the most appropriate urgent action. Whether it is forest fires, floods, or hurricanes, the location of affected people, infrastructure and resources are necessary to deliver mitigation, preparedness, response, and recovery. What's more, geospatial allows disparate data sets, from weather forecasts to health data, and traffic information to local authority records, to be combined through their shared location component, to give responders the whole picture. Optimal solutions can only be provided when the problems are well understood – and real-time, trusted and authoritative location data, is crucial to achieving that.

For responders to offer the highest value in emergency response, they need systems and tools that have the following characteristics:

- **Data Currency – Responders need to know what is happening as it is occurring if they are to respond correctly, in adequate numbers, and with the right tools. It's mission critical for responders to have data that is up to date, and continually updating.**

- **Integrated – Collaboration only works when different agencies are willing and able to share the data they have on a location. So regardless of who has collected data, there must be channels through which agencies can and are encouraged to share agreed national standards for interoperability.**

- **Secure – Though collaboration is crucial, it is important that only the right actors have access to the necessary data. This allows responders to collaborate and act fast , as well as preventing malicious acts.**

- **Clear – There has never been more data available, but this can result in a data overload, that may hinder emergency response. Knowing the most pertinent data and having clear visibility of it is paramount.**

- **Consistency – Using geospatial data to bring together multiple datasets; using location as the common framework.**

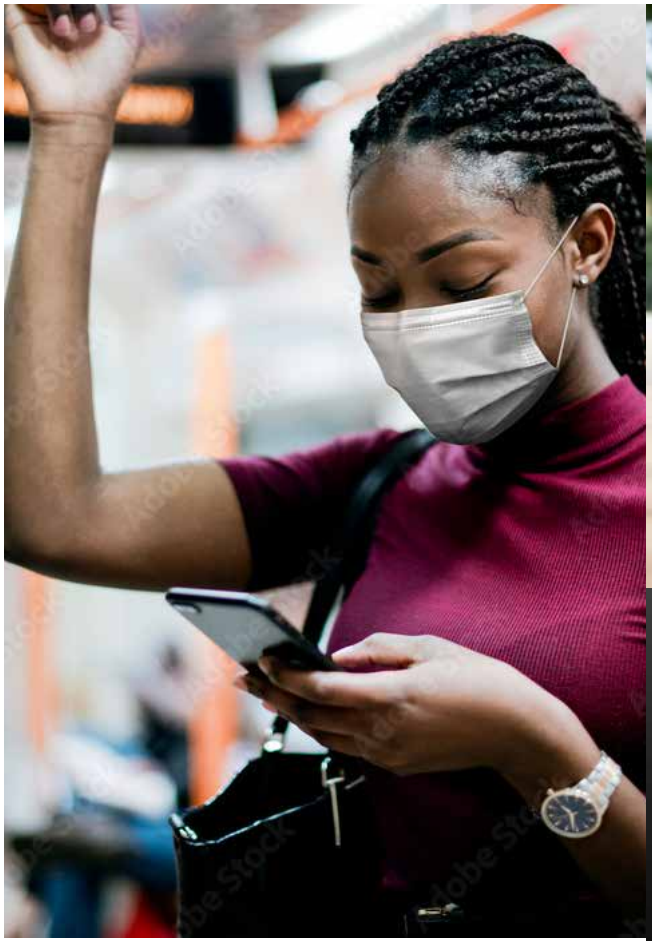
Even in more geospatially mature countries, data requests in the midst of an emergency often reveal lack of accessibility and currency of necessary information, with static digital or even paper maps being provided. The variable level of understanding of the data, and/or inconsistent availability, creates a gap in information that potentially poses a real risk to life, critical infrastructure, industrial assets and property when a time critical response is required, highlighting the importance of a shared, integrated framework.

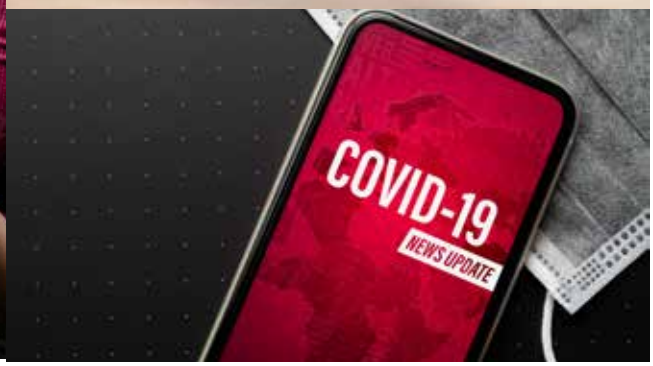
Pandemics and Epidemics

The Covid-19 pandemic has highlighted the importance of effective data sharing, and geospatial tools in many industries and sectors, including healthcare. The techniques used to monitor and mitigate the virus's spread could mark a watershed moment in the use of geospatial technology in international development, answering questions about resiliency in response where previously there were still much left to be asked.

Since the early days of the pandemic, researchers have been making use of highly visual geospatial tools and applications to record and report the virus' spread – from local to global levels. One of these, ArcGIS – the Geographic Information System (GIS) software provided by Esri – maps and, crucially, clearly communicates the spread and impact of the disease and guides decision-making around changes in policy or guidance, all through situational awareness dashboards.

One of the earliest and most well-known Covid-19 dashboards built using ArcGIS was put together by The Center for Systems Science and Engineering (CSSE) at John Hopkins University. Plug-and-play tools like ArcGIS make it possible for anyone anywhere to build mapping and data dashboards, provided they have some data to work with. The United Nations Department of Economic and Social Affairs Statistics Division (UNSD) have curated some of these dashboards on its Covid-19 data hub.





The proliferation of easy-to-use geospatial software and enabling tools has demonstrated the power and versatility of these previously relatively niche and specialist technology tools. As a result, we are seeing novel uses of technology and digital transformation as different countries customise dashboards, building them around their specific needs and the data they have available. Some of the most important insights and analyses have come from data at a subnational level; the story of the virus's spread in Lombardy in northern Italy, for example, was very different to the rest of the country.

Seeing different communities around the world, including those developing countries with very limited capabilities, build their own dashboards, based on their own languages, circumstances and priorities, has been impressive to watch. Through these tools, communities are communicated their experience of the virus as it impacted them specifically, but more importantly what metrics for progress looked like from their perspectives. While in the past some countries may have seen the limited value in the role of geospatial data in decision-making, the dynamic nature of the pandemic and urgency required in response has crystallised its importance.

One of the challenges of working with geographical data in reference to Covid-19 was the varying quality and timeliness of the data within countries. Data might be available at the national level, but not at the regional or local level, and often it was out of date. With a fast-moving situation like a pandemic, up-to-date information is paramount. With appropriate governance and institutional arrangements in place for cross-agency data sharing, many sources of data can be integrated into geospatial systems and dashboards. Chile is one example of a country that had high levels of disaggregated Covid-19 data that allowed for 'hot spots' and demographic differences to be examined.

The Covid-19 dashboards built by communities all around the world are a brilliant example of what is possible when countries and communities decide to take ownership of technology and use it to solve specific problems. With strong leadership and good governance, the skills learned from working with geospatial tools to tackle Covid-19 can be applied to solving other societal-level challenges outlined in the UN's SDGs, like tackling the climate emergency and working to end poverty.

CASE STUDY

Supporting NHS England's rollout of the COVID-19 vaccine

Using OS Highways data and speed data from the OS partner Basemap, OS gave NHS England more accurate journey times from population centres to proposed COVID-19 vaccination sites. With almost 50 million adults in England needing two doses of the COVID-19 vaccine, the programme needed comprehensive analytical input and a place-based approach to work.

To deliver the vaccine as fast and efficiently as possible, NHS England set up over 2,000 vaccination sites in familiar and convenient community locations. and needed to identify and prioritise potential vaccination sites. These sites needed to be chosen carefully to ensure comprehensive geographic coverage and meet the logistical challenges involved in the rollout.

The Government's priority list for the rollout of the vaccine was predominantly dictated by age and vulnerability, so NHS England needed to know how far people would have to travel to their nearest vaccination site, and that they were accessible by public transport. It was imperative to use accurate and reliable data to ensure high quality analysis.Integrated geospatial datasets gave NHS England the tailored, detailed data they needed to identify much more accurate journey times from population centres to proposed vaccination site locations. ensuring vaccine sites were reachable, accessible for all, and delivered in optimal settings for vulnerable people.

Ordnance Survey
SEE ≻ BETTER PLACE

Emergency Services

Effective disaster response by Non-Governmental Organisations (NGOs) or local government is contingent on access to reliable geospatial data. Investment in trustworthy and comprehensive mapping enables authorities to efficiently assess the range and extent of destruction – such as after a cyclone – as well as aid recovery by providing validation for the ownership of destroyed properties and businesses.

During and after an event such as flooding in an urban area, location context is vital information for emergency services, and for authorities to map the relationship between emergency calls and reports of flooding. This can be used to guide evacuation from areas under potential threat and optimise the deployment of procedures to protect infrastructure.

A town in Southwest England employed OS digital maps after severe flooding affected almost 10% of homes in the area. Using the detailed location information available, the community was able to engage government authorities with the extent of the damage to help direct recovery efforts and mitigate against future flooding.

Ensuring effective responses to emergencies that could threaten the safety of the population must be an absolute priority for governments and NGOs. Investment in information technology infrastructure is a crucial step to ensure the response to a crisis is as rapid, efficient, and coordinated as possible. Minimising the impact on people, properties, and infrastructure – which may be vulnerable to collective system failures – will open the doors to faster economic recovery and a more resilient society. OS is sharing the expertise acquired over more than 200 years at the forefront of geospatial innovation to help countries build resilience.

CASE STUDY

The power of geospatial data in resilience planning and emergency response

The 'beast from the east' cold weather event of 2018 dominated headlines in the UK, with snow causing traffic issues, school closures and disruption across the country. In Cumbria, the depth of the snow and challenging terrain resulted in significant issues accessing some communities.

Cumbria's multi-agency Strategic Co-ordinating Group (SCG), made up of partner agencies, secured military assistance to help access the most isolated communities, many of which had been cut off from all supplies for five days. OS supported under the UK's Mapping for Emergencies (MfE) agreement.

A helicopter was tasked with performing airdrops, taking emergency supplies to those who needed them most. This included food and groceries, coal, and logs for heating and electrical heating appliances.

The multi-agency group determined those areas at most need with OS' geospatial data being key for identifying the affected areas and priorities for the initial flight plans. Many of the agencies operated using their own GIS systems, with the teams ensuring data is shared during major incidents for maximum situational awareness.

To build the resilience required in response systems requires stakeholders and authorities to be prepared to share information prior to emergency events, not just during them. This leads to faster, and more informed decision-making, which then leads to overall better responses, as resources are more effectively and efficiently allocated.

The best way to enable the requisite level of data sharing is through establishing collaboration platforms and governance structures. These platforms will also ensure that everyone is working from the same authoritative data source, consolidating intelligence, and allowing responders to focus on the specific response actions required from them, instead of having to worry about the accuracy and cross-referencing of data.

An example is the unified platform of the European Commission's Copernicus Emergency Management Service, which uses satellite imagery and other geospatial data to map natural disasters, human-made emergency situations, and humanitarian crises globally. Delivering rapid mapping of affected areas within hours or days to help support emergency response management, the platform also provides risk and recovery mapping, whereby users can utilise highly detailed reference maps, and pre-disaster and post-disaster situation maps to glean more insight into how to best prepare for similar future emergencies.

Movement of people

In the event of large migrations of people, whether fleeing areas of conflict or evacuating from natural disasters, geospatial data has a vital role to play in ensuring their safety by both helping to manage their movement and getting the right aid to where it is needed most.

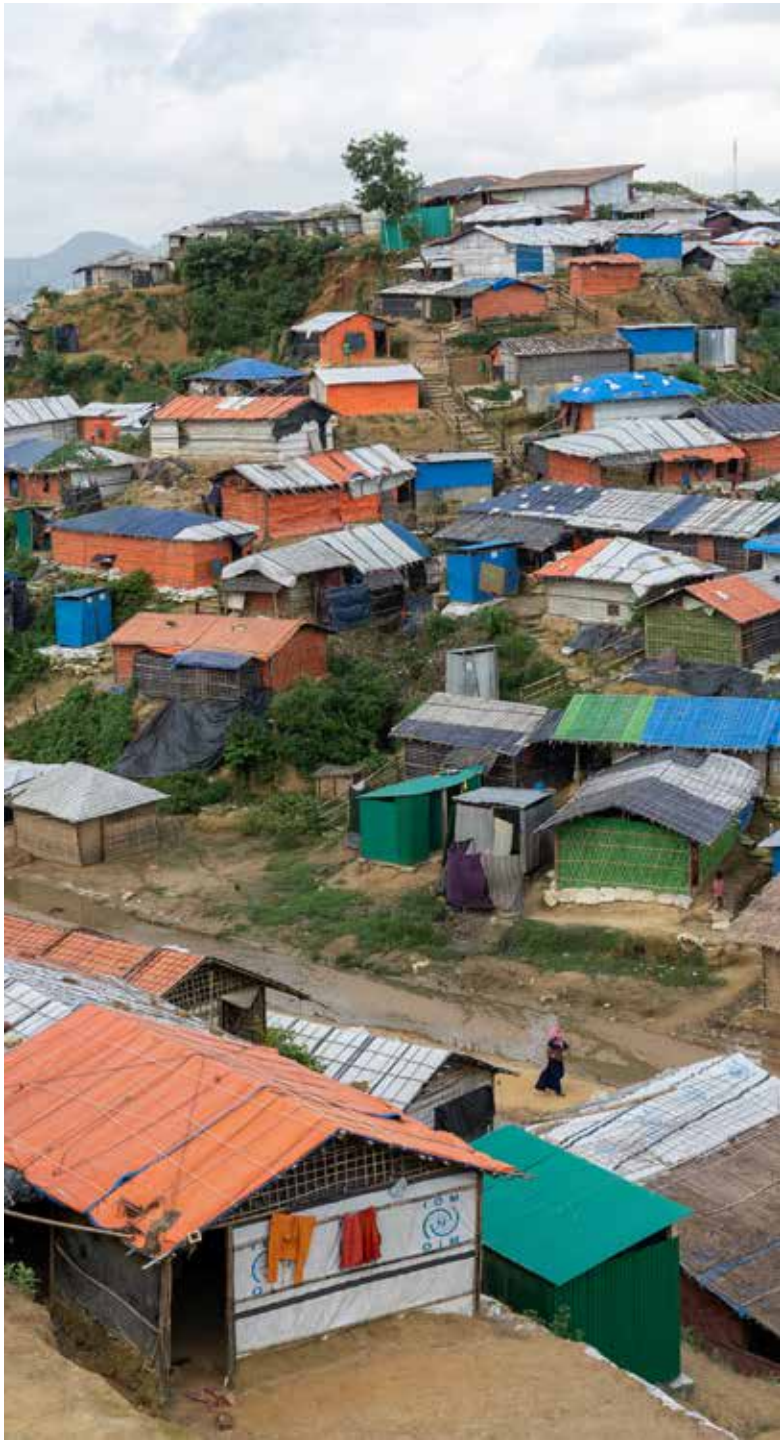
Mass migrations are largely unpredictable and tumultuous, particularly in the event of conflict, and therefore sourcing accurate data on the people, their numbers, and their location, cannot be done through traditional means such as censuses or government records. However, geospatial data affords officials the opportunity to get intelligence they need on what is occurring on the ground, and at a high level of detail.

During the Rohingya refugee crisis of the last decade, Bangladesh has hosted many migrants forcibly displaced. As of August 2021, Bangladesh was hosting over 890,000 Rohingya refugees in the Cox's Bazar District[8]. living predominantly in camps in Bangladesh's hilly countryside, where the risk of landslide is high. In addition, when the camps were established, plants and trees in the area were uprooted to make way. This had the knock-on effect removing the roots which helped to hold soil in place, meaning the hillsides are even more susceptible to landslide, particularly when the monsoon season hits.

To understand the effects and vulnerabilities those in the camps face, camp managers and other local officials incorporated NASA satellite observations into their analyses to help respond to and reduce the risk of landslides and other natural hazards.

By collecting data such as daily rain totals, and then cross refencing this with topological or geospatial data and camp population densities, for example, officials were better informed as to how best to design camp layouts and supply stores. This served to help prevent future disasters such as that in July 2019 whereby 14 inches of rain fell in 72 hours, causing 26 landslides with the camps[9]. This event left one individual dead and more than 4,500 without shelter.

It is through easily accessible, uniform geospatial datasets, combined with situation data that coordinated response to an unforeseeable crisis such as that experienced by Rohingya refugees is made possible.



8. UNICEF, 'Rohingya Crisis' - https://www.unicef.org/emergencies/rohingya-crisis
9. Columbia Climate School, 'Assessing Landslide Risk in Rohingya Refugee Camps.' - https://news.climate.columbia.edu/2019/11/22/landslide-risk-rohingya-refugee-camps/

4

RECOVERY

Building back better



While geospatial data is particularly effective in planning for and responding to changing environments and disaster events, it also has a very significant role to play in enabling regions and peoples to build back better, more resilient infrastructure, whether as a proactive plan to create a new type of living space, or as a rebuilding effort that improves on what went before.

In Indonesia, for example, there are efforts to build afresh with the assistance of geospatial data – combining a demand for new urban space with the urgent need for resilience.

Jakarta, the current capital, is the largest city in Southeast Asia. Due to the island rapidly sinking from rising sea levels, and the high population density, it was proposed to move the country's administrative functions to Kalimantan, just over 1,000km to the northeast.

Indonesia's National Development Planning Agency (BAPPENAS) outlined a number of factors that must be taken into consideration if the new capital location was to prove a successful endeavour, including strategic location in Indonesia's 17,000+ islands, defence and safety from potential conflict, pre-existing resilience to natural disasters like earthquakes, as well as spaciousness, crime rate, and existing metropolitan areas[10]. Traffic was also a major concern, as Jakarta regularly occupies a place in the top 50 most congested cities globally, meaning residents lose an inordinate amount of time to sitting in congestion, hindering quality of life, productivity, and having knock-on environmental effects.

In each of these considerations, geospatial data is the optimal tool by which planners can map and overlay numerous metrics against potential sites for the new Indonesian capital. Historic natural disaster data, for example, can quickly indicate areas which are prone to incidents, helping to plan where to best locate new infrastructure to avoid disasters, as well as how to plan emergency responses if and when such disasters occur.

Demographic and population density data can easily be overlaid with the likes of traffic data, medical facility provisioning, pollution hot spots, strategically defensible geographical features and more, not just at proposed sites in Kalimantan, but at other sites in Indonesia, allowing planners to learn from previous urban development experiences and policymakers to make informed conclusions on the final decision.

10. https://storymaps.arcgis.com/stories/ed551e7f782f4d89a3582777e5b1056e

CASE STUDY

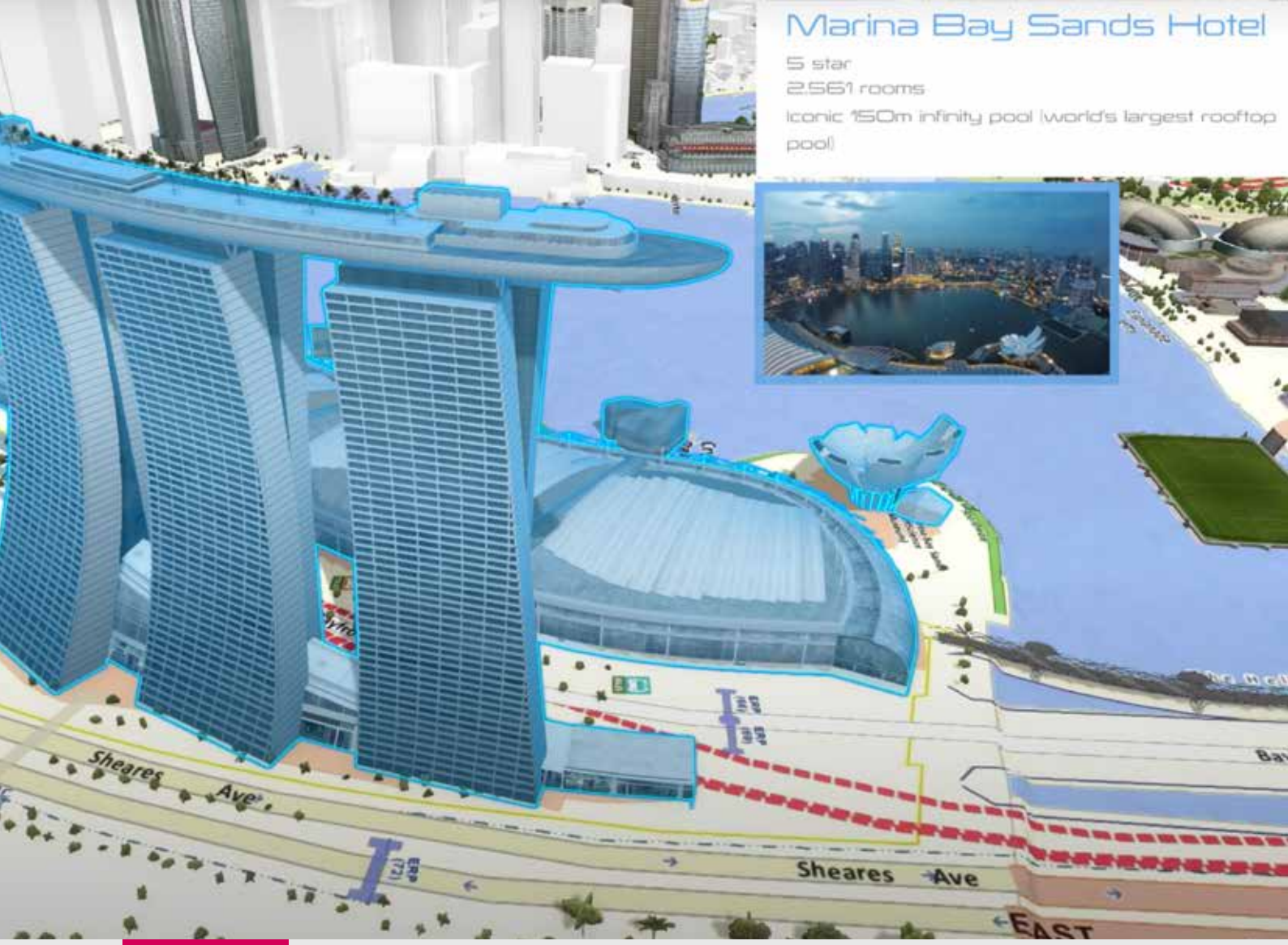
A single point of failure in Tadcaster, UK

A flood or fire affecting a single vital asset or piece of infrastructure can disrupt an entire community or beyond, a weak point in national resilience. In 2015, a flood event affecting the Tadcaster Bridge in North Yorkshire not only impacted local journeys but also utilities, communications and power services across the region. The bridge represented a 'single point of failure' which could produce a ripple effect across the town's economic and social life.

The learnings from this event represented an opportunity for improved resilience. Recovery efforts involved using geospatial data to reinstate crucial utilities that were disrupted and improve the future replacement infrastructure to prevent a similar event from occurring.

In addition to the physical proximity of individual assets, entire local or regional infrastructure systems can be interdependent and vulnerable to cascading effects. A well-documented case study is the Lancaster floods following Storm Desmond in 2015, where electricity failure led to the jamming of the emergency services phone lines and cessation of railway services, which might otherwise have provided a safe means of exit from the town.

Analysis of the road network can reveal which assets or crossings will have the greatest impact on population movements, freight volume or business activity. With such information, an increased monitoring regime and appropriate contingency measures can be put in place to prevent or minimise harmful disruption.



CASE STUDY

Singapore – the smart nation

Loosely defined, a 'smart city' is an urban region where information technology is the primary infrastructure. Singapore, however, looked to go one step further, and turn itself into a 'smart nation'.

Doing so required leveraging the nation's geospatial capabilities and infusing and strategically deploying geospatial data and technologies into as wide a range of the nation's workflows as possible.

As a result of these initiatives, Singapore was able to launch 'Virtual Singapore' – a live digital twin of the city created using LiDAR and real time dynamic data. Through integrating data from across government agencies, internet sources, IoT devices and sensors, Virtual Singapore provides the city with a virtual, authoritative platform through which to optimise its future urban planning based on geospatial, topographical, topological, analytical, semantic, real time, and legacy considerations. This is an invaluable tool when evaluating resilience of key systems such as transport networks, considering future resilient infrastructure, and responding to events.

Using a digital twin as your city's sandbox

What is a digital twin?

It is a realistic, digital, or virtual representation of an asset's processes and systems. Unlike tools that simplify reality, a digital twin is as detailed and dynamic as the built and natural environment it represents. It is a near real-time digital model of your city which can be tested against various scenarios and remodelled ad infinitum.

A digital twin is the most cost effective and accurate means by which infrastructure alterations can be developed and tested, with potential issues identified and remediated before any physical work is undertaken.

Transport links to communications networks, energy grids to power stations, hospitals to health centres: whatever your focus, you can combine data to plan and model your project across its entire life cycle all with pixel perfect precision.

Location data enables digital twins to be consistent and compatible. It is the binding element in every asset, helping to create a more inclusive, prosperous, and resilient future. A digital twin relies on location data that's clear, trusted, and true.

Digital twins bring multiple varied layers of geospatial data into a single platform, including underground assets, buildings and infrastructure, real time weather, traffic flows at differing times, pollution, population densities and demographics, and more. Singapore's authorities use digital twins to improve decision making on, for example, where to place solar panels calculating how much sunlight particular faces of buildings receive. The 3D model also allows for sophisticated simulations of how the city's infrastructure works with technological developments, as it has rich semantic data covering everything from traffic information, building use to construction materials, to population data and environmental conditions.

In this way, geospatial data helps not only to optimise and best manage existing infrastructure as urbanisation continues apace, but it also guarantees city growth and expansion can be proactive at every stage. It enables not just enhanced visualisation and better ideation of smart cities, but it tests them to ensure they will not only succeed, but that they also easily adopt new technologies coming down the line. Technologies such as autonomous vehicles, electric vehicles, single-login applications for numerous municipal and private services, urban drones, smart streets, and more, all of which add to the global resilience of Singapore against environmental, economic, and security threats.

GAIN AN ADVANTAGE

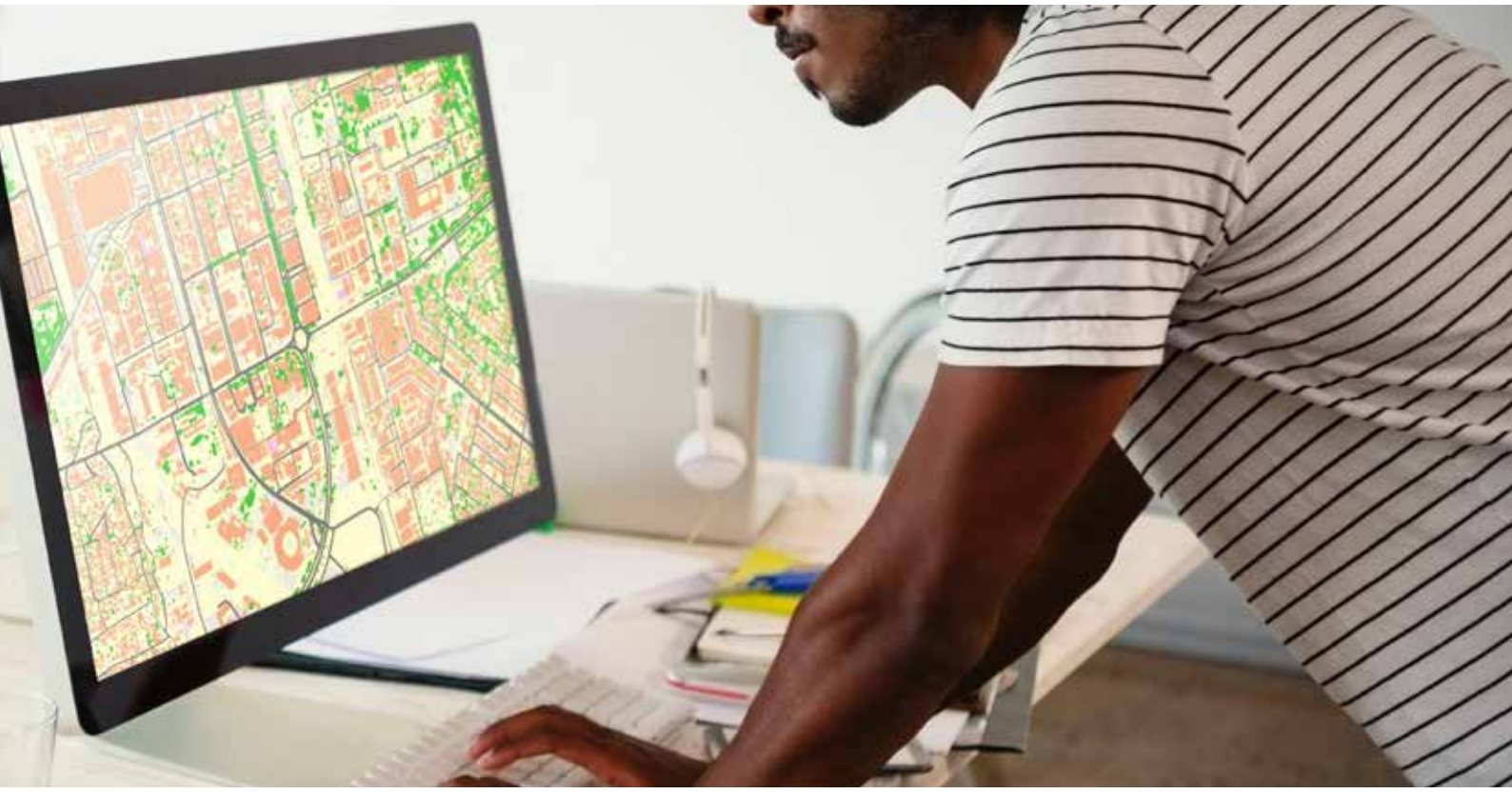
5

Improve future resilience with geospatial information

Geospatial data is the key ingredient in building more resilient nations. Through the near ubiquity of information, it affords every type of stakeholder, its potential to provide insight is virtually limitless. Giving time and location to people, incidents, land formations, pollution concentrations, and more provides a frame of reference to previously intangible concepts and quantities which can then be layered upon one another to give the fullest picture of what an area looks like, what is occurring there, and how it interacts with others.

To maximise your geospatial data opportunities is not simply about having the largest quantity of data available, it is about the quality of that data, and the ease with which it is shared with those who need it. It must be de-siloed, and highly interoperable for it to be the golden thread that is required between different agencies, both in the public and private sectors.

OS has the unique capabilities and vast experience of geospatial data that puts it at the very forefront of helping nations collect, visualise, contextualise, and analyse their data to create the resilience they want to see in their societies. Using our consistent geospatial frameworks can provide you with the ability to make planning and response decisions based on uniform criteria and with access to similar types of information, at both your national and local government levels.



5 steps towards harnessing geospatial for a more resilient nation

01 Identify the unique challenges facing your nation

Every country is unique. What are the main resilience-related problems you hope to solve with geospatial information?

02 Understand key policy drivers at a national and local level

What are the different factors driving your decision making? For example, environment, health, transport, disaster management.

03 Identify key stakeholders and users of geospatial information

Who is working with geospatial data in your nation? Which industries/ regions/people stand to benefit from resilience-focussed planning?

04 Work with them to understand their objectives and issues

What is keeping your stakeholders up at night? Establish how geospatial information can help solve weak points in current setups, and what would enable them to bake in resilience in future planning and initiatives. Identify common pain points and best practice to look for opportunities to share data across government departments to meet common policy agendas.

05 Build services using data that help meet these challenges

What services would help to address your policy drivers and stakeholder requirements to become more resilient? Identify duplication of efforts and encourage stakeholders to collect data once but use many times.

Gain an advantage with a geospatial readiness assessment

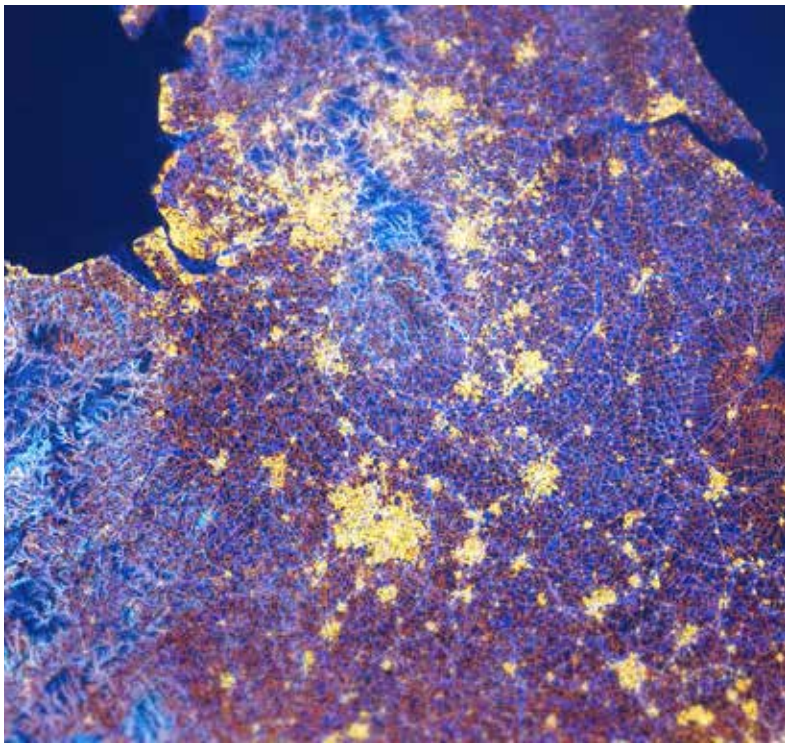
Geospatial data drives economic growth, creating value in the private and public sectors, and enabling a geospatial ecosystem that unlocks further growth.

Geospatial information helps governments build prosperous, sustainable futures for its citizens by:

- Growing your economy
- Fuelling the data economy
- Predicting and preventing crises
- Responding to climate change
- Driving sustainable development
- Enhancing government efficiency
- Tackling the negative effects of urbanisation

Building national digital base maps is a core process in enabling your nation's digital economy to flourish, but base maps are also a fundamental enabler in significantly enhancing the resilience of your systems, process, and infrastructure, whether through long-term planning, or through establishing more effective response mechanisms.

Ordnance Survey (OS) can support all organisations in breaking down the silos of data that exist and building a spatial approach to data that ensures meaningful collaboration between authorities both nationally and internationally. It can help



governments with improving data access and control, data granularity, temporal data, security-enabled collaboration, and the implementation of non-discriminatory mapping that provides a full picture of a region.

The global economic value of geospatial services is roughly 0.2% of GDP.

To tap into this growing market, governments should consider a geospatial readiness assessment from an established mapping agency. This will help to identify how to upgrade their digital geospatial ecosystem in a way that maximises overall resilience, wider societal benefits, and economic growth.

The return on investment on assessing and expanding a nation's geospatial readiness reaches far beyond any cost-benefit analysis.

Ordnance Survey offers geospatial readiness assessments to all governments wherever they are on their geospatial journey. They consider:

- Collecting and managing data
- Data quality and data governance
- Product and service development
- Corporate governance
- Stakeholder engagement
- Supply chain and operations management
- Using geospatial technologies

To find out more visit os.uk/resilientnation

Take our free online assessment **visit os.uk/gra**

Ordnance Survey provides consultancy and managed technology services in a wide range of areas including basemap creation, landscape monitoring, data exchanges, geo-readiness assessments, and land administration.

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