The Executive's Playbook on Earth Observation

WHITE PAPER

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Images: Midjourney, Getty Images

Contents

Foreword

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As organizations face increasing economic uncertainty, resource constraints, environmental pressures and intricate operational risks, Earth observation (EO) offers virtually unparalleled insights. With rising greenhouse gas (GHG) emissions and escalating global temperatures – 2024 surpassed 2023 as the hottest year on record[1] – the world is on a path to more extreme weather events, such as heatwaves, wildfires and droughts, which disrupt economies, devastate communities and strain resources. Melting ice caps and rising sea levels are threatening coastal cities, while shifting climate patterns are endangering food and water supplies for millions of people. The cost of inaction is escalating, forcing businesses and governments alike to improve resilience and adapt quickly.

In this new normal of simultaneous environmental, social and economic crises, the need for accurate, responsive information about the Earth's physical, biological, chemical and anthropogenic systems is clear. With over half of global GDP (gross domestic product) dependent on natural resources today,[2] accurately understanding and predicting risk is not only important for long-term strategizing, but is also critical for business operations today.

Organizations that effectively leverage insight-rich technologies are poised to unlock previously unconsidered opportunities, proactively manage risks and drive sustainable growth. EO reveals the layers and interdependencies in complex systems that other data sources do not express. By capturing multiple dimensions – tracking not only what occurs but precisely where and how events interact across time and space – spatial insights offer a full-spectrum view of reality and deliver actionable intelligence at an incomparable scale.

In early 2024, the World Economic Forum, in collaboration with Deloitte, the Massachusetts Institute of Technology (MIT) Media Lab and a group of 50 industry, technology and climate leaders, studied the future of EO technologies[3] as well as the transformative economic and environmental value they can generate.[4] Notably, they estimated that EO can contribute $3.8 trillion to global GDP from 2023 to 2030 and eliminate 2 gigatonnes of GHG emissions every year. Yet, despite this potential and the EO innovations occurring on the "supply-side" of the market, much of the value remains unrealized.

The EO industry finds itself at a crossroads. Yes, commercial providers of EO capabilities continue to enter and disrupt the market, with an estimated 90% of EO satellites launched in 2023 being commercially owned,[5] up from only 15% in 2014. However, even with this boom in commercial EO providers, many uses of EO data still tend to centre around traditional public sector-focused applications. To help accelerate the adoption of EO technologies across high-value commercial and public-sector uses, their value proposition should be more systematically illustrated in organizational contexts, and implementation considerations broken down so that all leaders – and not just technologists – feel confident in taking steps to adoption.

This EO playbook, created by the World Economic Forum in collaboration with Deloitte, provides a practical guide to adopting EO, outlining the types of problems that can most benefit from EO solutions. Furthermore, it outlines the key considerations for effectively implementing these solutions in a way that empowers executives across an organization, by breaking down technical contexts for non-technical users while offering technical users a broader perspective of the overarching framework within which they operate.

By the conclusion of this playbook, champions of EO will be equipped to clearly articulate a compelling business case for EO's adoption and begin implementing a solution that generates greater economic and environmental value for organizations, people and the planet.

Executive summary

The collective ability to measure the built environment and natural phenomena through Earth observation (EO) continues to increase in precision and scale. With thousands of possible applications, the potential value of this data is vast and growing; however, the overwhelming majority of this value remains unrealized, largely because of flagging adoption rates.

Some of the root causes of this flagging adoption are beginning to be addressed by a growing number of actors across the EO ecosystem. New commercial EO providers increasingly provide unique data sources that are right-sized to individual organizations' contexts, while traditional open-source government EO providers continue to improve the accessibility of their larger datasets. However, this boom in supply-side innovation, with EO data becoming easier to use and more valuable than ever before, does not mean that EO is always the best solution for every challenge an organization faces.

Because of the nearly limitless potential applications of EO, end users can gain a competitive edge by understanding where and how it is best suited to provide value. Unlocking EO's potential requires strategic alignment with organizational objectives, a clear identification of high-value applications, and a nuanced approach to implementation that goes beyond traditional technology adoption frameworks.

In essence, to successfully incorporate EO into planning and operations, organizations should follow a three-step process to build a compelling case for adoption:

1 **Articulating the value proposition:** EO can offer insights into a variety of organizational issues; however, where it is uniquely positioned to generate value often depends on the key physical and temporal dimensions of the issue at hand. Begin by clearly identifying the issue at hand that EO is uniquely positioned to solve and the benefits of using EO compared to, or as a complement to, alternative solutions. These issues, typically grouped into broadly applicable categories, focus on strategic issues related to understanding an organization's reliance on both natural and humanmade assets. EO excels when addressing large-scale areas, frequent data collection needs, ecosystem-wide issues, trend analysis through historical data, and integrating spatial with non-spatial data.

2 **Bolstering strategic alignment:** When identifying a problem EO can best solve, it is important to align that problem to the organization's strategic objectives to build a compelling case for return on investment. It is important to position EO initiatives as organizational priorities rather than as standalone projects. An EO-enabled solution often generates cross-functional value for the portfolios of the entire executive leadership team, from strategy to finance, technology, operations and sustainability.

3 **Charting the execution strategy:** Effective EO integration demands nuance, especially when assessing technical readiness and expertise, establishing governance, and navigating the complex EO ecosystem of data, platform and tool providers. The best approach for implementing EO is often context-specific, and there is no one-size-fits-all solution. Organizations should determine when to leverage open-source data, when to partner with commercial providers, and how to blend EO insights with proprietary data to generate actionable intelligence.

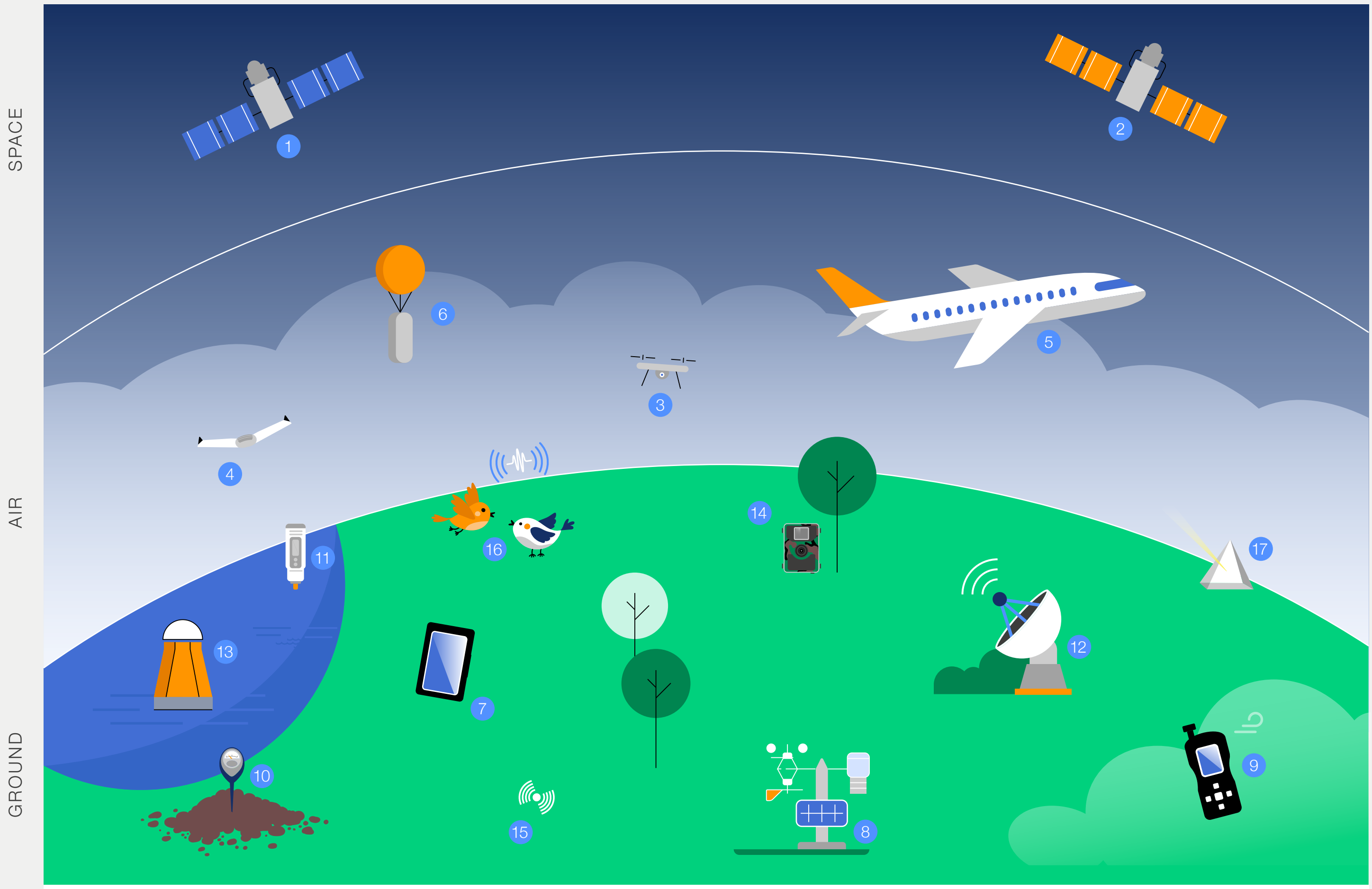
Who is this playbook for?

This playbook is designed for senior executives, strategists and decision-makers across private, public and non-profit sectors who are considering how EO can help reach their organizational goals. It empowers leaders aiming to leverage environmental intelligence for strategic planning, operational resilience and sustainable growth. It provides practical resources to help organizations align EO with high-level goals across functional areas including strategy, finance, technology, operations and sustainability.

Introduction

Earth observation refers to the collection of information on both natural phenomena and human activities on Earth, covering physical, chemical, biological and anthropogenic (human) systems. EO data is captured through a growing ecosystem of sensors, using both remote-sensing technologies and “in-situ” data sources.

FIGURE 1 **EO technologies by altitude**



1. Low Earth orbit (LEO) satellite
2. Geostationary orbit (GEO) satellite
3. Rotary drone
4. High-altitude drones (fixed-wing UAVs)
5. Crewed aircraft
6. Stratospheric balloon
7. Mobile phone
8. Weather station
9. Air-quality monitor
10. Soil-moisture probe
11. Water-quality sensor
12. Ground-based radar (aka LiDAR)
13. Ocean-data buoy
14. Camera trap
15. Seismic and vibration sensor
16. Acoustic sensor
17. Light-based spectrometer

Remote sensing involves detecting and monitoring an area or object by measuring its physical properties at a distance, acquiring data via airborne and spaceborne platforms such as satellites, piloted aircraft, high-altitude platform stations and drones.

In-situ data is gathered through GPS-enabled devices, internet of things (IoT) sensors and a range of human-operated, automated and crowdsourced measurements.

These data sources power the EO value chain. Data acquired from both remote-sensing and in-situ sources undergoes processing to correct distortions and enrich information. Advanced analytical techniques are then employed to extract actionable insights from the processed data and disseminated through specialized EO platforms.

The "supply side" of the EO value chain, consisting of data acquisition, processing and analytics providers, aims to facilitate access to EO insights for end users. The demand side comprises end users in agriculture, financial services and energy companies.

On the supply side of the value chain, various business models arise. Some EO providers own and operate their own satellites, looking to sell the resulting generated data. Others create proprietary platforms or tools that generate insights using publicly available data or data purchased from other EO providers. Others are fully integrated and provide a full suite of capabilities, from data to tools to analysis.

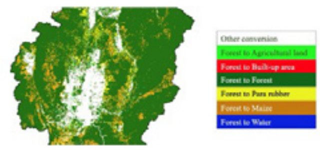
These varied data sources provide varying types of data, each best suited to capture differing measurements with unique applications. The figure below outlines some of the more common data types captured by remote-sensing EO satellites.

The "Amplifying the Global Value of Earth Observation" Insight Report published earlier this year offers a deeper understanding of EO's impact – including its potential to contribute $3.8 trillion to global GDP from 2023 to 2030 and eliminate 2 gigatonnes of GHG emissions every year.[6] It explains the strong confluence of market forces driving this value and outlines the industries that stand to gain the most from EO, including agriculture, mining, oil and gas, electricity and utilities, financial services, insurance, supply chain and transportation.

FIGURE 2 **Select types of remote-sensing EO data**

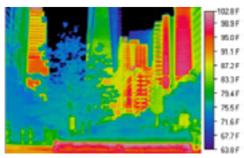
Optical and multispectral

Captures reflected sunlight across multiple wavelengths to monitor land, vegetation and water.



Thermal and infrared

Detects emitted heat energy from Earth's surface, independent of sunlight, to monitor temperature and moisture.

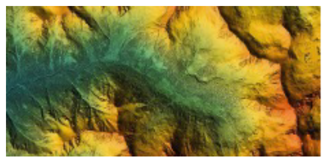


Synthetic aperture radar (SAR)

Sends microwave pulses that penetrate clouds, capturing detailed surface structures regardless of weather or light conditions.

Light detection and ranging (LiDAR)

Uses laser pulses to create highly detailed 3D maps of the Earth's surface.



However, for this value to be realized, EO data must be more widely used, in both commercial and public contexts. And for this, potential end users of this data must become empowered to overcome the traditional barriers to EO adoption.

From an end-user perspective, systematic challenges have prevented EO data from being fully integrated into organization-wide solutions. Historically, analysing EO data has required specialized technical expertise. Traditional, large and unwieldy datasets, although often free, frequently did not provide the precision needed to derive actionable insights at the organizational level.

Recently, EO providers and platforms on the supply side have begun to actively address these barriers. Government and civil society actors continue to make strides in not only providing publicly available EO data with new geographic coverage and data types, but also processing that data so that it is "analysis-ready" for organizations to deploy in their contexts. Meanwhile, commercial innovators continue to make new sources of EO data available, complementing existing publicly available information with the precision that is often needed to derive insights at the smaller site level instead of the larger regional level.

At the same time, rapid advancements in artificial intelligence (AI) algorithms, including machine learning (ML) techniques and multimodal large language models (MLLMs), are being applied to EO datasets to make them more technically accessible.[7]

This convergence of multiple digital tools and methods, including the integration of Big Earth Data and citizen science or customer reference data, is driving rapid automation, customization and simplification of EO applications. Today, thanks to these supply-side innovations, the EO market is better poised to deliver on the promise of its potential value than it has ever been before.

However, demand-side barriers to entry remain. Specifically, many potential end users struggle to identify optimal EO use cases best suited to derive organizational value among the myriad of potential EO applications. Even when relevant use cases are identified, organizations often seek help in understanding how to navigate the complex EO data and tool ecosystem. Now, more than ever, end users must take a measured, systematic approach to utilizing EO in their organizations, to understand the value EO can generate, how it aligns with broader strategic priorities and the best path towards execution and institutionalization. To do so, organizations can follow the "ABC" of EO, as outlined in Figure 3.

FIGURE 3 | **The ABC of EO adoption**

1 Articulating the EO value proposition

This section addresses the following questions:

Which organizational challenges can EO uniquely address, and why is EO particularly suited to these challenges?

Which criteria can determine whether EO is the optimal solution for identified challenges?

How can high-impact EO applications be identified within a strategic framework?

EO represents a vital tool for organizations to better understand their physical assets, the impact the environment may have on those assets and those assets' impact on their environment. While EO can benefit many organizations, it provides the most substantial value in cases requiring large-scale, high-frequency or remote data. Given the breadth of potential use cases, end users may find themselves in the "paradox of choice," unable to choose or prioritize applications for implementation. To overcome this analysis paralysis, it is essential to clarify the unique and organization-specific value proposition of EO within a systematic framework.

1.1 Common problems that EO can help address

The key to articulating a compelling value proposition is to first understand how EO addresses specific challenges that are critical to an organization's success – the challenges where approaches void of EO may fall short in delivering timely, accurate and actionable insights, hindering decision-making across the organization.

To grasp EO's fundamental value proposition, high-level categories of use are helpful. These categories are not meant to be exhaustive. Instead, they represent some of the primary ways in which organizations can use EO to create value. Table 1 highlights these categories as well as the strategic issues within these categories where EO can make a significant difference.

> **Earth observation data is not usable in a vacuum – you need to have a problem-first mindset.**
>
> Awais Ahmed, Pixxel

TABLE 1 **Common problems addressable with EO**

Category	Description	Common problem to address
Consumer experience	Providing individual users up-to-date environmental information (e.g. air quality data and weather forecasts), typically through public services	Customers desire increasingly transparent and up-to-date information on various environmental factors that may impact their health or day-to-day activities
Early warning	Detecting environmental events – like floods and wildfires – to bolster planning, response and recovery	Delay in responding to natural hazards results in higher damages and loss of life
Environmental impact monitoring and disclosure	Measuring environmental outcomes to enhance transparency in ESG, TNFD (Taskforce on Nature-related Financial Disclosures) and TCFD (Taskforce on Climate-related Financial Disclosures) reporting, and ensure accurate disclosure of environmental performance.	Lack of consistent and reliable environmental data for accurate reporting leads to challenges in meeting regulatory requirements and stakeholder expectations
Post-event analysis and recovery	Analysing environmental changes to direct emergency response and measuring the extent of damages	A lack of data from areas recently impacted by environmental events leads to slower assessments of the aftermath, hindering effective recovery and resource allocation for recovery efforts
Precision agriculture and aquaculture	Predicting and monitoring in-season agricultural performance and yield	Without precise information on crop yield at scale, farmers and aquaculture managers face inefficiencies in resource use (e.g. in use of water, fertilizers and feed) that may lead to an outsized environmental impact
Route optimization	Monitoring transport routes in concert with positioning, navigation and timing (PNT) data by detecting potential environmental disruptions and offering alternatives based on environmental impact	Unanticipated delays along transportation routes caused by inadequate knowledge of real-time weather, road conditions or geographical barriers may lead to service disruptions and higher costs
Site selection	Identifying new operating sites for large-scale infrastructure	Inaccessible potential sites like mining fields and fishing grounds and potential areas of natural resources, or sites with hard-to-measure indicators of output, often rely on predictions instead of direct measurements, leading to a higher risk of failure
Supply-chain monitoring	Detecting changes to physical goods' supply chains and their impacts on international commerce and ecological indicators	Limited visibility into physical supply-chain sources, especially in regions prone to environmental disruptions, may lead to production delays and potential legal liability from unethical practices
Vulnerability analysis	Characterizing and assessing the risks posed by environmental changes and other hazards that may materially impact people, physical assets and operations	Difficulty in predicting areas highly susceptible to disasters or environmental stress may lead to inadequate preparedness and hinder proactive risk mitigation

By recognizing the categories of use, and the common problems within those categories that EO can help address, organizations can prioritize the potential applications. This is the first step towards articulating a value proposition and implementing EO at scale. However, simply experiencing a common issue that spatial data can address does not necessarily mean that the optimal fit is an EO solution. To determine if EO can contribute to an organization's strategic objectives, the identified problem should exhibit certain features that make EO a particularly suitable solution.

1.2 Features of a problem best suited for EO

Organizations looking to extract the most value from comprehensive EO solutions that rely primarily on satellite-based remote sensing can do so by evaluating a given problem across several dimensions, including: geographical coverage, parameter sensitivity, location of interest, response needs and time series.

Asking the following questions can help clarify when EO will deliver the most value:

Coverage: Is this a large-scale issue requiring consistent, comparable data across geographically dispersed locations?

Localized For site-specific measurements or small areas where broad geographic consistency is not required, ground sensors provide high granularity and pinpoint accuracy, but are limited in cross-location comparability.

Regional As coverage needs expand to regional or sub-regional scales with specific conditions, drones or aerial surveys can provide detailed and coherent data within a mid-sized area. For example, comparing environmental health across different wetlands within a state.

Broad-scale For geographically dispersed phenomena or expansive regions such as deserts, oceanic zones or countries, **satellites** offer the most practical solution, consistently capturing broad-scale data that is directly comparable across sites.

Parameter sensitivity: Does the problem require precise measurements, or will broader, less detailed data suffice?

High sensitivity For highly sensitive parameters, such as specific pollutants or soil nutrients that require contact, **ground sensors** and sampling are best. There are many phenomena that can be measured on the ground but not directly from space, such as pH (potential of hydrogen) levels.

Moderate sensitivity For moderate sensitivity across regional scales, **drones with multispectral sensors** can detect subtle environmental changes such as invasive species across diverse habitats.

Low sensitivity For broad, less granular parameters, **satellites** provide extensive monitoring, detecting large-scale patterns like sea-surface temperatures, with capabilities improving at rapid rates.

Location of interest: Is the problem located in a physically inaccessible area where non-intrusive data collection is needed to avoid disrupting sensitive ecosystems or endangering personnel?

High accessibility If the use case covers easy-to-access areas, such as urban centres or fields, **on-the-ground teams** can more easily deploy **specialized sensors** for detailed monitoring.

Moderate accessibility In partially accessible regions like forested zones, **drones** can be leveraged to monitor deforestation while **camera traps** and **acoustic sensors** can capture data on biodiversity.

Low accessibility In remote or inaccessible regions, such as those with strict regulations, conflict zones or polar areas, **satellites** are indispensable. Satellites can monitor glacier dynamics for example, bypassing the logistical requirements for human intervention or by complementing data collected by researchers.

Response needs: Is timely information critical, requiring frequent data collection and rapid delivery to support fast decision-making, or is a slower response acceptable?

Rapid response In emergencies like wildfires, **airborne imagery** provides timely data that allows for fast response.

Moderate response Where frequent but not real-time data is required, **drones** are versatile, providing regular updates. Recent advancements in the development of smaller, cost-effective satellites have enabled frequent revisits and more real-time data.

Delayed response For studies needing periodic data rather than immediate updates, **satellites** offer consistent revisit times and broad coverage, ideal for observing gradual changes like land-use shifts.

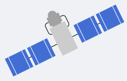
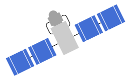
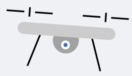
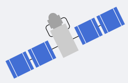
Time-series analysis: Is there a need to analyse historical data to understand long-term trends?

Short-term monitoring For studies that require high-frequency data over shorter time frames, **ground-based sensors** are the most effective. This is especially valuable in settings where parameters can change quickly. For example, ground sensors can be used by hydrologists to track flood dynamics in real time during rainfall events.

Seasonal to annual monitoring For time-series analysis across seasons or multiple years, **drones** can cover regions with periodic flights that capture data at specific intervals. They are a useful data source in studies on, for example, seasonal vegetation growth or erosion patterns across a forested landscape.

Long-term trends For time-series analysis spanning years to decades, **satellites** are ideal due to their consistent revisit schedules and ability to capture large-scale changes. EO solutions include satellite-based remote sensing with high temporal resolution that enables organizations to track changes over time.

TABLE 2 | Best-suited tech based on features

Use case	Features						
	Description	Coverage	Location of interest	Response needs	Time series	Parameter sensitivity	Recommended technology
Clean-energy site selection	Identifying optimal locations for renewable energy projects such as wind, solar and hydroelectric installations needs analysis of environmental, geographical and social factors						**Space:** Synthetic aperture radar (SAR) satellite imagery enables assessment regardless of weather or time of day, making it valuable across large geographic regions, providing critical layers of information for assessing land suitability, solar radiation levels, wind speeds, topography and environmental impact zones
Illicit fishing monitoring	EO aids in detecting and monitoring illegal fishing activities in protected waters or exclusive economic zones						**Space:** High-resolution satellite imagery and AIS (Automatic Identification System) data enable tracking and monitoring of fishing vessels in remote areas to identify suspicious activities and patterns
Cropping	Optimizing crop yield and quality while minimizing resource use relies on an understanding of field variability and crop health by detecting variations in chlorophyll content and water stress						**Air:** Multispectral cameras on drones provide timely data on soil moisture to support day-to-day operations, particularly irrigation decisions, so crops receive adequate water without any wastage
Insurance premium calculation	Assessing risk factors helps determine appropriate insurance premiums for properties and assets						**Space:** Satellite imagery is used to evaluate environmental risks such as flooding, wildfires and other natural hazards, over a long period of time and on an ongoing basis to facilitate updating of premiums
Heritage conservation	Preserving historical sites, buildings and landscapes requires assessments of structural integrity and gradual changes						**Ground:** 3D laser scanning (LiDAR) creates detailed models of structures, capturing contour and surface features to enable conservators to monitor fine-scale changes (such as microcracks)

EO can drive value across thousands of different applications. In practice, however, organizations should first identify whether the problem they are trying to solve belongs to a common category of EO use and then determine if that problem exhibits features best suited for EO.

EO is most beneficial when at least two or three of the following requirements are to be met: examining large areas, addressing problems that require frequent or timely data collection, spanning ecosystems, needing historical data to analyse trends, or the need to complement spatial data with non-spatial data. In addition, EO's true value emerges when combined with complementary data like socio-economic data and sensor networks. This multi-source approach enhances accuracy, context and the ability to address multi-dimensional challenges.

Of course, EO has valuable applications outside of the nine categories described in Table 1, and not all these EO features need to be addressed for a single application to be a viable use of EO. For instance, if the area of interest is too large or remote for ground-based monitoring, EO could be an excellent solution even if timely data collection is not needed. Conversely, if organizations are dealing with hyper-localized issues that require very fine-grained data, EO might not be the best fit, even if the problem falls squarely within one of the identified categories. The purpose of these categories and questions is to help guide organizations' decision-making process by highlighting scenarios where EO can be uniquely beneficial.

2 Bolstering strategic alignment: Connecting EO with executive priorities

This section addresses the following questions:

In what ways does EO align with the core objectives of different executive roles?

Which approaches provide comprehensive support for EO adoption in various departments?

How can EO initiatives be embedded into organizational missions as integral, long-term priorities?

Ultimately, the EO value proposition hinges on demonstrating a clear return on investment. Once the issue and its EO-relevant features are identified, the financial or strategic value generated by these insights should be outlined. To make this case, organizations need to connect the dots between EO's data-driven capabilities and measurable benefits, highlighting how EO can be a powerful tool for sustainable growth across the functions and departments that come under the ambit of various leadership roles. Navigating conversations on adopting EO and cultivating internal champions requires a strategic approach that aligns EO's capabilities with the organization's long-term goals and priorities.

EO presents an opportunity that adds value to every aspect of an organization's mission, and harnessing its full potential requires more than just data and technology – it needs a collaborative, organization-wide commitment. Successfully implementing EO solutions is not the responsibility of a single department but an integrated effort involving many different leaders, each bringing a unique perspective and set of objectives that can amplify EO's impact when aligned with the organization's broader goals.

Notably, the following roles can gain a substantial advantage by leveraging EO solutions.

- **Strategy executives**, who define pathways towards long-term organizational competitive advantage.
- **Financial executives**, who focus on financial planning and fiscal compliance.
- **Technology executives**, who oversee data integration and long-term product innovation.
- **Operations executives**, who aim to optimize efficiencies while minimizing risk.
- **Sustainability executives**, who look to achieve positive climate and nature outcomes.

> **A multi-pronged, multidisciplinary approach is key to achieving impact with this kind of data. Bringing together points of view from finance, technology, sustainability and policy is critical to building durable solutions.**
>
> Amanda Leland, Environmental Defense Fund

2.1 EO for strategy executives

Strategy executives are responsible for guiding the long-term vision and growth of their organization, with a mandate that often cuts across executive functions. Their focus is not only on charting the organization's future goals but also on guiding financial, technological, operational and sustainability strategies in a way that drives cross-functional innovation and competitive advantage. By leveraging the timely and precise insights of EO, the entire executive team is empowered to make more informed decisions, positioning the organization for leadership in sustainable growth and innovation across all areas, but especially through the following:

- **Market analysis and supply forecasting:** EO provides strategy executives with insights into the availability and health of key resources, such as crops or fisheries, allowing relevant organizations to better adjust sales strategies based on projected product availability. By leveraging satellite imagery and data analytics to monitor agricultural production or other resource outputs, sales teams can price products better to proactively match predicted supply with expected demand.
- **Competitive market positioning:** EO provides strategy executives with insights into untapped markets, emerging opportunities and competitor activity. By analysing EO-derived insights, organizations can make informed decisions to enter new markets ahead of competitors, optimize resource allocation and adapt to shifting market conditions. As an example, an oil and gas company might analyse competitor expansion rates and its own rates of infrastructure and asset utilization (e.g. based on operational hours) to fine-tune its strategies and stay competitive by understanding and anticipating competitors' moves.
- **Catering to eco-conscious markets:** EO empowers executives to provide clients with data-driven transparency across supply chains, helping them meet growing customer expectations for ethically and sustainably sourced products. EO can track the movement and origin of materials, identify environmentally harmful practices (e.g. deforestation and wasteful water use) and enable adherence to sustainability commitments in a more traceable manner. Strategy executives can use EO data to showcase where their products are sourced from and how they align with environmental standards, maintaining trust for customer retention and potentially charging a price premium. For example, for certain products known to have adverse environmental impacts if sourced unethically (such as palm oil), companies can get an up to 30% price premium for verified proof of origin.[8]

CASE STUDY 1

AXA's wildfire risk prevention tool

Articulating the value proposition

The increasing frequency and severity of wildfires, exacerbated by climate change, comprises a complex and evolving risk that needs innovative solutions. Traditional risk models often struggle to account for the broad range of factors influencing wildfire behaviour, such as climate variability, land use changes and human activity.

Using geospatial imagery and AI, AXA's new risk prevention tool provides real-time, predictive insights that go beyond historical data. The use of satellite-based systems to monitor and analyse over 20 risk factors – such as topography, vegetation and proximity to infrastructure – enables a dynamic, forward-looking approach to wildfire risk management. This tool enables continuous updates and the development of detailed risk maps, helping clients assess and manage their exposure to wildfire risk with unprecedented accuracy.

Bolstering strategic alignment

By using predictive analytics, AXA provides clients with actionable, timely insights, enabling them to proactively manage risks rather than react to damage after the fact. This approach not only improves operational efficiency but also minimizes the financial impact of wildfires, which have caused billions in economic and insured losses globally.

Additionally, offering this innovative service enhances AXA's position as a leader in risk management solutions, demonstrating its commitment to leveraging cutting-edge technology in addressing emerging environmental risks.

Charting the execution strategy

The execution strategy for AXA's wildfire risk prevention service involved a strategic partnership with Kayrros, a leader in geospatial analytics, to develop a cutting-edge tool that integrates satellite data and AI-driven predictive models. This service is built on a "Digital Commercial Platform," providing commercial clients with easy access to risk maps and analyses that are updated regularly. As the service expands across Europe and globally, AXA plans to scale its offerings while ensuring the quality and accuracy of the data by continuously integrating new geospatial insights.

2.2 EO for finance executives

Finance executives are tasked with maximizing financial return while minimizing financial risk to maintain the long-term financial health of their organizations. For a financial executive, the key criteria when considering a new strategy or technology often include how it can enable effective risk mitigation, financial performance and regulatory compliance. EO can offer a range of economic benefits for organizations, including:

- **Improved financial forecasting:** EO provides valuable data that can enable a financial leader to forecast macroeconomic market trends more accurately, enabling more informed financial planning and investment strategies. Demand signals that manifest through physical characteristics – such as the number of cars in a particular retail store's parking lot or the number of ships in a particular port – can often be better understood using EO, leading to data-driven financial planning decisions.

- **Increasingly effective risk mitigation:** Financial executives can use EO data to assess how extreme weather events, like floods and wildfires, might affect their assets. The United Nations estimates that $44 trillion of economic value generation is moderately or highly dependent on nature and its services and, as a result, exposed to risks from nature loss.[9] Given this dependency, the loss of natural ecosystems and biodiversity poses substantial risks, including those pertaining to resource scarcity, ecosystem service disruption, regulation and reputation. Financial executives can leverage EO to gain an improved understanding of these risks and support the development and implementation of strategies to mitigate their financial exposure.

2.3 EO for technology executives

Technology executives play a critical role in ensuring that an organization's technology infrastructure is forward-thinking, efficient and aligned with strategic business goals. This responsibility includes managing the integration of new applications into the overall information architecture and technology strategy. EO can enhance an organization's existing technology suite to better enable broader strategic goals with:

- **Timely insights:** Unlike data-gathering methods that may rely on manual reporting or site visits that can take days or weeks to update, EO provides timely access to critical information, allowing for faster interventions. Moreover, many EO platforms – complemented by burgeoning AI capabilities – now offer pre-analysed, ready-to-use insights, allowing organizations to reduce the time-consuming process of data analysis. This equips business units with actionable intelligence on demand, improving their ability to respond to emerging challenges and opportunities.

- **Improved data quality:** EO data enriches the depth and accuracy of insights by providing an additional layer of information that complements existing systems without overhauling them. It provides more context for decision-making, especially when combined with internal company datasets, such as operational, supply chain or sales data. Additionally, EO can serve as a secondary source of corroboration for ground-level observation and reports. By cross-referencing EO data with existing datasets, organizations can validate findings so that decisions are based on reliable, accurate and traceable information. This view enables business units to make more informed, data-driven decisions that account for multiple variables and contexts.

- **Monitoring of environmental footprint:** Today, achieving environmental, social and governance (ESG) targets and the United Nations Sustainable Development Goals (SDGs) is a high priority within organizations, and according to Gartner's 2022 sustainability survey, 90% of executive leaders agree that technology is essential to improving sustainability.[10] However, accurately tracking an organization's technology footprint remains a challenge. EO can help by providing comprehensive, up-to-date insights, including for high-energy and high-usage technologies (such as AI). This enables technology executives to monitor their environmental footprint more effectively, manage resource consumption and align with ESG goals to ultimately support sustainable business growth and compliance.

CASE STUDY 2

GEO's Global Water Sustainability Initiative (GEOGLOWS)

Articulating the value proposition

GEOGLOWS, powered by the European Centre for Medium-Range Weather Forecasts (ECMWF) ensemble prediction system, addresses the pressing need for accurate and timely flood risk data in the insurance and reinsurance industries. By delivering reliable 15-day ensemble forecasts alongside 80 years of historical streamflow data for rivers worldwide, GEOGLOWS enables proactive flood risk management.

This innovative, open-access tool supports insurers by forecasting river discharge for live event responses, allowing for quick estimation of flooding scope, prioritization of recovery efforts, and effective loss mitigation. GEOGLOWS' global scale, high-resolution data, and flexible forecasting capabilities make it a vital resource for generating flood maps and optimizing coverage and pricing decisions.

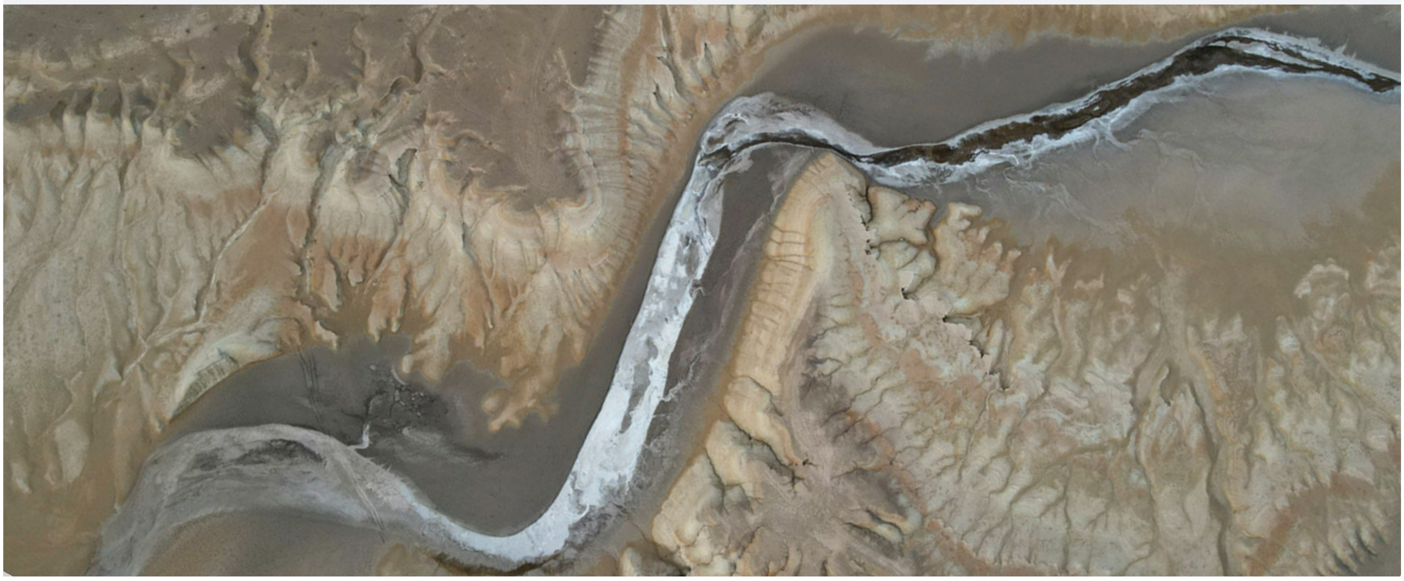
Bolstering strategic alignment

For the insurance sector, GEOGLOWS enhances operational efficiency and supports risk mitigation strategies while contributing to broader environmental sustainability goals. By filling gaps left by traditional flood monitoring tools, particularly during the critical early stages of flood events, GEOGLOWS positions insurers as leaders in leveraging advanced technology for climate resilience. The integration of satellite water altimetry data from the National Centre for Space Studies (CNES), in-situ measurements and AI algorithms since 2022 has further enhanced the accuracy of global streamflow forecasts, adapting the service for local applications. This continuous innovation underscores the insurance sector's commitment to improving disaster response and fostering sustainable practices.

Charting the execution strategy

GEOGLOWS has established strategic partnerships with key organizations, such as the National Centre for Space Studies (CNES) and other satellite data providers, to ensure the continuous provision of high-resolution river flow data across diverse geographies. These collaborations have enabled the integration of satellite water altimetry data into GEOGLOWS' forecasting models, while partnerships with local hydrological agencies have facilitated the incorporation of in-situ measurements, enhancing forecast accuracy.

The implementation has followed a phased approach, starting with pilot projects in selected regions to validate performance and refine integration processes. These pilots have involved close collaboration with local stakeholders, including insurance companies, government agencies and community organizations, to ensure the tool meets regional needs. Training programmes and workshops have been conducted to build user capacity, ensuring effective utilization of GEOGLOWS' data and insights. Following successful pilots, the system has been scaled up to additional regions, with continuous monitoring and evaluation to assess impact and identify areas for improvement. By combining high-resolution hydrologic modelling with accessible open data, GEOGLOWS has empowered insurers to respond effectively to disasters, improve risk assessments and keep insurance policies relevant and responsive to environmental changes.



2.4 EO for operations executives

For operations executives, whose main objective is to ensure business activities run in a smooth, efficient and cost-effective manner, EO can be a valuable ally by providing:

- **Optimized logistics:** EO can significantly enhance logistics management by providing timely data on transportation routes, weather patterns and resource availability. Operations executives can leverage this data to optimize delivery schedules, minimize fuel consumption and reroute transportation in response to unforeseen disruptions. Together, this improves speed and cost-effectiveness in supply chain operations. Integrating EO data with existing supply chain control-tower data – which provides end-to-end, near real-time visibility across an organization's entire network, including suppliers, manufacturers and business partners – allows for even greater logistics optimization. For example, by using EO to optimize ship route efficiency, companies can lower fuel consumption by up to 3%,[11] resulting in reduced costs and direct abatement of GHG emissions.

- **Enhanced resource management:** Effective resource management is crucial for operational efficiency, and EO provides valuable data to help executives identify optimal facility locations and resource allocation strategies. By analysing environmental conditions, demand patterns and geographical features, EO enables operations teams to make informed decisions such as where to place warehouses, production sites or renewable energy installations. For example, EO data may show areas where water is becoming increasingly scarce, which should inform manufacturers that water-intensive production processes need to be relocated to areas with lower risk.

2.5 EO for sustainability executives

Sustainability executives look to enable their organizations to meet stated environmental goals, framing the strategic and tangible sustainability impacts of proposed changes for both internal and external stakeholders, so that the full benefits can be understood. This can include contributing to conversations assessing how new implementations could impact growth, risk and operational strategy. The powerful combination of data-driven insights and reliable reporting that EO provides makes it an essential tool for sustainability executives to inform their strategies.

- **Improved impact tracking:** EO offers sustainability executives a reliable way to measure the impact of environmental initiatives through digital measurement, reporting and verification (dMRV). It provides accurate, quantifiable data by tracking key sustainability metrics such as carbon emissions, deforestation rates and land use changes at scale, with better efficiency than alternative technologies. This data can in turn guide decision-making, allowing executives to assess the effectiveness of their initiatives and adjust strategies as needed.

- **Targeted environmental interventions:** Using EO to monitor natural resources and environmental changes, sustainability executives can identify where restoration, preservation, conservation and mitigation efforts should be focused. EO data can help pinpoint regions suffering from resource depletion, land degradation or biodiversity loss, enabling the development of more targeted strategies to mitigate these issues. For example, water conservation efforts can greatly benefit from EO-derived insights, especially in remote areas, where the identification of areas of overuse or pollution can enable executives to implement measures to reduce waste and shrink the organization's environmental footprint.

- **Regulatory compliance and trustworthy reporting:** As new ESG standards and laws are implemented, sustainability executives will increasingly look for solutions – like EO – that provide them with confidence to offer reliable reporting and meet new regulations. Over 50% of essential climate variables can only be measured at scale from space,[12] which makes EO a critical enabler of ESG compliance at multinational organizations whose activities span multiple geographies. By incorporating EO data into emissions tracking or resource usage reports, sustainability executives can deliver more trustworthy, externally validated information. This transparency not only strengthens regulatory compliance but also builds stakeholder confidence, ensuring that environmental commitments are backed by objective, direct data.

CASE STUDY 3

Radiant Earth's "Fields of the World"

Articulating the value proposition

The European Union Deforestation Regulation (EUDR) has created an urgent need for reliable information on global agricultural production to confirm that products are not contributing to deforestation. While EO data may not be universally applicable for monitoring all agricultural activities, it has proven invaluable in creating a scalable and trustworthy data product that would otherwise be unaffordable.

Bolstering strategic priorities

To address this need, Radiant Earth set out to **accelerate regulatory compliance** by improving access to global field data, while leveraging open-source data instead of proprietary data or algorithms so that regulatory implications do not adversely affect farmers' livelihoods or agricultural sectors.

Charting the execution strategy

This initiative has been bolstered by the **formation of a consortium** led by Radiant Earth and the Taylor Geospatial Engine, involving key stakeholders such as Bayer, Varda.ag, Microsoft, Planet, Arizona State University, Washington University in St. Louis and the World Resources Institute. This collaborative effort, characterized as a "focused research organization"[13] has been instrumental in establishing shared metadata standards, open-source code and open data, thereby facilitating rapid progress and broad participation. A significant milestone achieved by the consortium is the **creation of a metadata specification**, fiboa (field boundaries for agriculture),[14] which enhances the interoperability of field boundary data.

Additionally, the publication of methodologies, models and data through the Fields of the World project[15] has laid the groundwork for a foundational dataset, promoting further advancements in the application of EO data and ML in agriculture. It is designed to support the training of diverse models that can identify field boundaries in different geographical contexts. The Fields of the World data comprises 1.6 million parcel boundaries and over 70,000 samples spanning 27 countries across four continents and is available for anyone to use.[16]

The collaborative efforts and strategic initiatives undertaken by this consortium have not only addressed regulatory needs but also paved the way for a more sustainable and data-driven approach to global agricultural practices.

As illustrated, EO presents opportunities across every aspect of an organization's mission and can deliver a variety of benefits that align with various executives' goals. And although each of these executives has their priorities and related functional targets, their roles and responsibilities often overlap and blend. A strategy executive should account for operational risks when determining a long-term vision, just as a sustainability executive should understand drivers for growth in the context of their own initiatives. To navigate these cross-cutting opportunities, EO champions can consider multiple approaches for the execution of an EO solution, dependent on the specific needs of each organization.

3 Charting the EO execution strategy

This section addresses the following questions:

Which key factors contribute to an effective EO implementation strategy, from technical infrastructure to partnership models?

How should an organization approach the build, buy or partner decision when adopting EO capabilities?

Which operational and technical considerations are critical to achieving a sustainable, impactful EO integration?

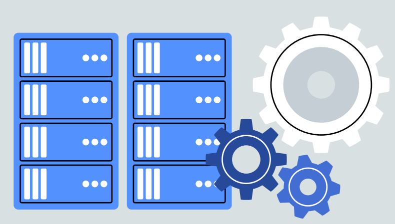
After articulating an organization-specific EO value proposition and aligning that value with executive priorities, organizations can determine the proper approach to strategically implement EO to solve the identified problem. To do so, it is beneficial to foster spatial thinking at an organizational level, not merely in isolated projects.

Furthermore, like other specialized technologies, an entire ecosystem is available to support an organization's implementation of EO. In fact, because of the technically complex nature of most EO solutions, this support system often plays a vital role in many EO implementations.

Effective EO implementation relies on three core pillars that support each other. These pillars – readiness and resources, pathways to implementation, and durable impact – create a flexible framework to guide EO adoption.

> **Organizations can only become truly data-driven by adopting a multifaceted approach that values data as an asset, ensuring robust security, governance and privacy.**
>
> Roland Scharrer, Stanford University

FIGURE 5 **Pillars of EO adoption**



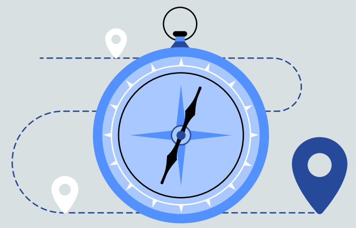
Readiness and resources

Understanding readiness across technology, operational capabilities and resource allocation is important for effective EO integration.

— **Assess technical and operational readiness** by evaluating the infrastructure, data handling, storage solutions and expertise needed to process, analyse and visualize EO data types

— **Establish a governance structure** to strengthen alignment with organizational priorities and promote cross-departmental collaboration

— **Align EO adoption with financial planning** by assessing cost structures, evaluating return on investment (ROI) and exploring emerging models that make EO more accessible and cost-effective



Pathways to implementation

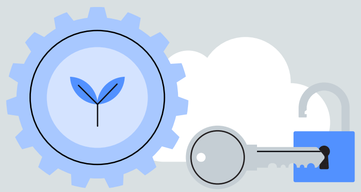
Selecting the right implementation pathway enables tailored EO adoption that meets organizational needs.

— **Understand the urgency of EO-derived insights** to decide if rapid, pre-built EO solutions are of value or if a more tailored approach is necessary

— **Identify the level of control needed** to maintain data privacy and regulatory compliance, especially for sensitive, regulated sectors

— **Determine the level of customization needed** by evaluating if unique data sources or custom algorithms are required for the issue at hand

— **Explore the role of open-source and commercial data and tools** to find the right balance between cost-effective and high-precision resources



Durable impact

Sustaining EO initiatives over time calls for forming strategic partnerships and continuous improvement.

— **Establish integration needs with enterprise systems** to embed EO insights into day-to-day operations

— **Evaluate potential partnership opportunities** by identifying strategic collaborations that can enhance EO capabilities and reduce costs and risk through shared expertise

— **Develop a change management plan** to build EO literacy, champion a data-driven culture, and reinforce organization-wide adoption through capacity-building efforts

— **Measure impact and iterate** by establishing KPIs and continuously monitoring the effectiveness of EO data in achieving business and sustainability goals

3.1 Readiness and resources

Assessing technical and operational readiness

Most EO implementations demand a robust technical foundation, which includes infrastructure and expertise in remote sensing, data science and software engineering. Accessing EO data typically demands expert involvement, which limits its reach to industries without geospatial knowledge and access to specialized tools. This dependency hinders the scalability of EO across industries that would benefit from it but lack in-house knowledge and resources.

Assessing an organization's current infrastructure and expertise for handling these complex datasets is critical. A capability assessment should be conducted to evaluate the existing technical infrastructure, data-handling practices and human resources. Where gaps exist, organizations can partner with specialized EO providers, or even identify an end-to-end service provider to simply purchase the EO insight itself.

For organizations able and willing to develop in-house resources, given the rapid evolution of EO solutions,[17] it is not sufficient to solely focus on current capabilities – they should also anticipate future technological needs. For example, today's EO platforms leverage cloud-based storage and AI-driven analytics to process the terabytes of data produced by satellites, but soon, advances in edge computing may decentralize data processing closer to the satellite, reducing latency and enhancing timely decision-making. Increasingly, organizations need experts familiar with multi-source data fusion (combining satellite, aerial and ground-based sensors). Organizations may also need the capacity to handle novel data types, like hyper-spectral imagery or synthetic aperture radar (SAR) data, both of which provide unique insights but may come with significant and specific data processing demands.

Establishing a governance structure

A clear governance structure is essential for coordinated adoption of EO that aligns with organizational objectives. Appointing an EO champion at the executive level strengthens alignment with business goals and facilitates the integration of EO insights into strategic decision-making processes. This leadership role is crucial for cross-departmental collaboration, as it illustrates EO's value to actors across the organization, providing consistency in its use. To further embed EO's applicability and use across the entire organization, an EO working group consisting of stakeholders from relevant departments – such as sustainability, IT, compliance and operations – should be established. This group would define key metrics (e.g. the accuracy of monitoring systems and required data latency) and promote alignment with corporate objectives, managing all aspects of EO implementation, from data acquisition to ethical use policies.

> **We're very lucky to live in a time when we have such abundant EO data, but we need to close the gap between the C-suite and data specialists. We know more about our world than ever before and it's imperative that we translate this knowledge into clear value, bridging the gap between observing the Earth and taking strategic action.**
>
> Jed Sundwall, Radiant Earth

Aligning EO adoption with financial planning

EO implementations typically include significant upfront costs related to high-resolution imagery, third-party software or custom analytics services. Traditionally, organizations have had to purchase large datasets, even when only small portions are needed. The traditional EO business model, which relies on a price-per-image framework, is inherently flawed and impedes the widespread adoption of EO technologies. Indeed, such a system ties revenue directly to the number of satellites deployed, making it difficult to achieve economies of scale. Launching satellites into orbit is unlikely to become sufficiently affordable to support widespread adoption in industries requiring continuous monitoring, such as agriculture.

Furthermore, the pricing structure for EO data often does not align with customer needs. Typically, data is sold in entire satellite scenes covering extensive geographic areas, whereas most customers require insights for smaller, more specific regions. This leads to prohibitively high costs for organizations operating on narrow margins, limiting EO adoption to high-value, niche applications.

> **To compare it to the music industry, we are still in the 90s, when people bought albums to listen to a fraction of it, their favourite song.**
>
> Max Gulde, constellr

However, the influx of commercial entrants is driving innovation in business models, aligning EO investment requirements more closely with expected returns. The business model is shifting, and soon, organizations may only need to pay for the specific pixels or data they need.

So, while costs can appear prohibitive at present, the long-term costs and return on investment through efficiency improvements, regulatory compliance and sustainability outcomes can vastly outweigh these costs.

3.2 Pathways to implementation

Understanding the urgency of EO-derived insights

When immediate access to operational EO tools is needed, such as responding to regulatory pressures or unexpected environmental events, organizations may opt for pre-built EO solutions. This is especially beneficial when the organization's use case aligns with industry-standard workflows – such as monitoring urban heat islands, assessing flood risk or managing deforestation. While it may lack deep customization, buying delivers speed, scalability and immediate integration into existing workflows, allowing organizations to quickly gain value from EO data.

Identifying the level of control needed

For organizations handling sensitive data, EO systems may need to be built in-house to maintain control over the data life cycle. This is especially important when EO data intersects with data-sensitive and highly regulated environments like defence, financial services and energy. In-house EO systems can aid in compliance with privacy regulations like the EU's General Data Protection Regulation (GDPR), Health Insurance Portability and Accountability Act (HIPAA), or industry-specific regulations that dictate how geospatial data is handled. Furthermore, implementing robust encryption and secure APIs (application programming interfaces) for data sharing helps protect EO data throughout its life cycle. This helps organizations avoid fines, legal action or reputational damage.

Beyond protecting sensitive data, it is crucial for organizations to identify and leverage their existing non-EO data to drive business advantages. Understanding the types of proprietary data a company possesses can help in creating a unique competitive moat. For instance, a seed business may have proprietary farmer data that can be used to train in-house EO and AI services for better crop estimates. By integrating EO data with proprietary datasets, organizations can develop more accurate models, enhance decision-making processes and create tailored solutions that provide a competitive edge in the market.

CASE STUDY 4

UNICEF’s Children’s Climate Risk Index

Articulating the value proposition

Children are uniquely vulnerable to climate and environmental hazards such as droughts, floods and severe weather, especially when they live in areas where these risks overlap. As these hazards intensify, UNICEF recognizes the need to identify regions where children are at the greatest risk, so as to facilitate targeted responses to safeguard their well-being. Because of the need to monitor large-scale areas over a long period of time, UNICEF has identified EO to be best suited to understand the risk these particularly vulnerable populations face.

Bolstering strategic alignment

Leveraging decades of EO data, UNICEF built the Children’s Climate Risk Index (CCRI). This in-house capability uses EO to model and assess a wide range of climate hazards at the sub-national level, providing comprehensive insights into the climate risks that children, and others around the world, face. UNICEF’s efforts to build an in-house solution began with a clear mandate from the Sustainability and Climate Change Action Plan (SCAP) 2023-2030, which underscored the urgent need for **targeted mitigation** in order to protect the most vulnerable children from the worst impacts of a changing climate and degrading environment.

Charting the execution strategy

Following the call to action, UNICEF established a dedicated Climate and Environment Data unit in 2023. They decided to build a tailored EO solution for their internal needs, building upon existing solutions from trusted and established partners. This allowed them to maintain control, customize workflow and integrate with existing systems, which ultimately increased adoption of EO tools across their programmes.

This initiative led to UNICEF generating the first comprehensive overview of children’s exposure and vulnerability to the impacts of climate change, developed to help prioritize action to support those most at risk. This report compiled geographical data, which highlighted how exposed children are to different climate-related shocks, and ranks countries on a scale of risk, from low to extremely high.

With CCRI, UNICEF has the insights needed to strategically protect children, promote climate resilience programmes and empower youth advocacy, all of which support a safer and more sustainable future for the next generation.

Determining the level of customization needed

EO workflows are not one-size-fits-all. Certain sectors may require highly specialized analytics, such as precision agriculture or coastal monitoring, where customized algorithms track water salinity or crop health. Sometimes, third-party datasets may lack the specificity needed, necessitating custom data acquisition, such as commissioning satellite tasking for specific regions. If third-party datasets are insufficient (e.g. lacking specific spectral bands or time-series resolution), organizations may need to acquire their own high-resolution imagery or collaborate with satellite operators to gather bespoke datasets.

Exploring the role of open-source and commercial data and tools

Leveraging open-source EO data such as Landsat of the National Aeronautics and Space Administration (NASA) and Sentinel satellites of the Copernicus programme, as well as open-source tools such as QGIS, may provide cost-effective alternatives for geospatial data analysis. These datasets and platforms are often sufficient for applications concerning broad scopes and long-term historical trends but may lack the precision required to fully answer the issue at hand. (Precision refers to minimizing the error of a recorded measurement compared to its ground truth measurement, and temporal resolution refers to how often a measurement is captured.) For certain use cases, this level of resolution can be crucial to elevate the data from merely informative to essential for decision-making.

An active global community is working to create open-source tools that can be combined to create EO data analysis pipelines. NASA, European Space Agency (ESA) and many commercial satellite companies are funding and contributing staff time to the creation of shared open-source EO resources such as the Geospatial Data Abstraction Library (GDAL), the SpatioTemporal Asset Catalogs (STAC) specification and the Sensor Tasking API (STAPI).

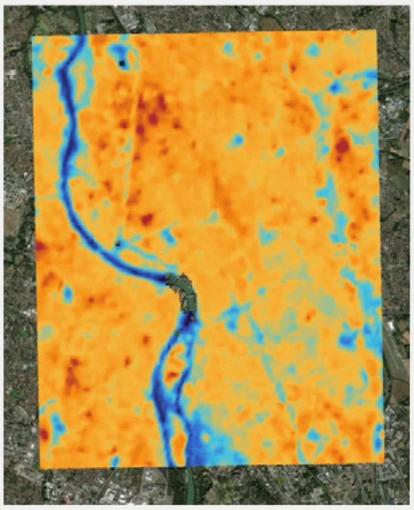
These are lower resolution but powerful tools that can be combined to create powerful and scalable services that include both open-source and commercial offerings.

The progression beyond basic feature detection further enhances the value of EO data. Crossing a threshold of accuracy transforms the data from being informative to also being actionable. For example, constellr's high-resolution thermal imagery can capture detailed temperature variations across urban environments, agricultural fields and natural landscapes, providing insights that are crucial for applications such as urban heat island assessment, crop health monitoring and disaster management.

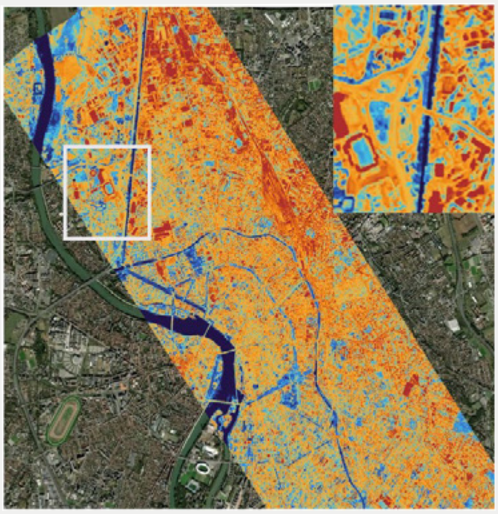
Often when testing a new Earth observation use case, the best way is to start small with a pilot project, ideally with external partners or vendors. Many use cases might not be a good fit for an organization, so it may only make sense to invest in building something in-house at scale after it has already been tested and validated.

Rohini Swaminathan, United Nations Children's Fund (UNICEF)

FIGURE 6 **Example of precision variability by data source**



OPEN SOURCE



COMMERCIAL

Source: Constellr

The following image compares constellr's thermal imagery with open-source data from lower-resolution sources. highlighting the enhanced granularity of commercial data.Organizations can test an EO solution with open-source data and opt for commercial data when higher resolution is needed. Additionally, it is important to consider how small satellites and newer sensors often use open data from Landsat and other satellites for calibration and validation to improve quality control. Often, when deciding on an EO solution, a blend of publicly available and commercially available data and tools may enable an organization to maximize its return on investment. Furthermore, regardless of the data sources and tools chosen, organizations will often still require EO expertise to analyse and interpret the insights from EO and have unique considerations when deciding how to best build, buy or partner to acquire their needed EO capabilities.

3.3 Durable impact

Integrating with enterprise systems

For EO to drive long-term value, it must be fully integrated into an organization's existing data ecosystems, rather than operating in a silo. The transition from data to analytics to actionable insights, which ultimately need to be executed to generate value, can be streamlined despite the challenges. Initial implementation may take place in sandbox environments to test EO's capabilities, but long-term success requires seamless integration into enterprise systems like enterprise resource planning (ERP), customer relationship management (CRM), human resources (HR) and analytics platforms.

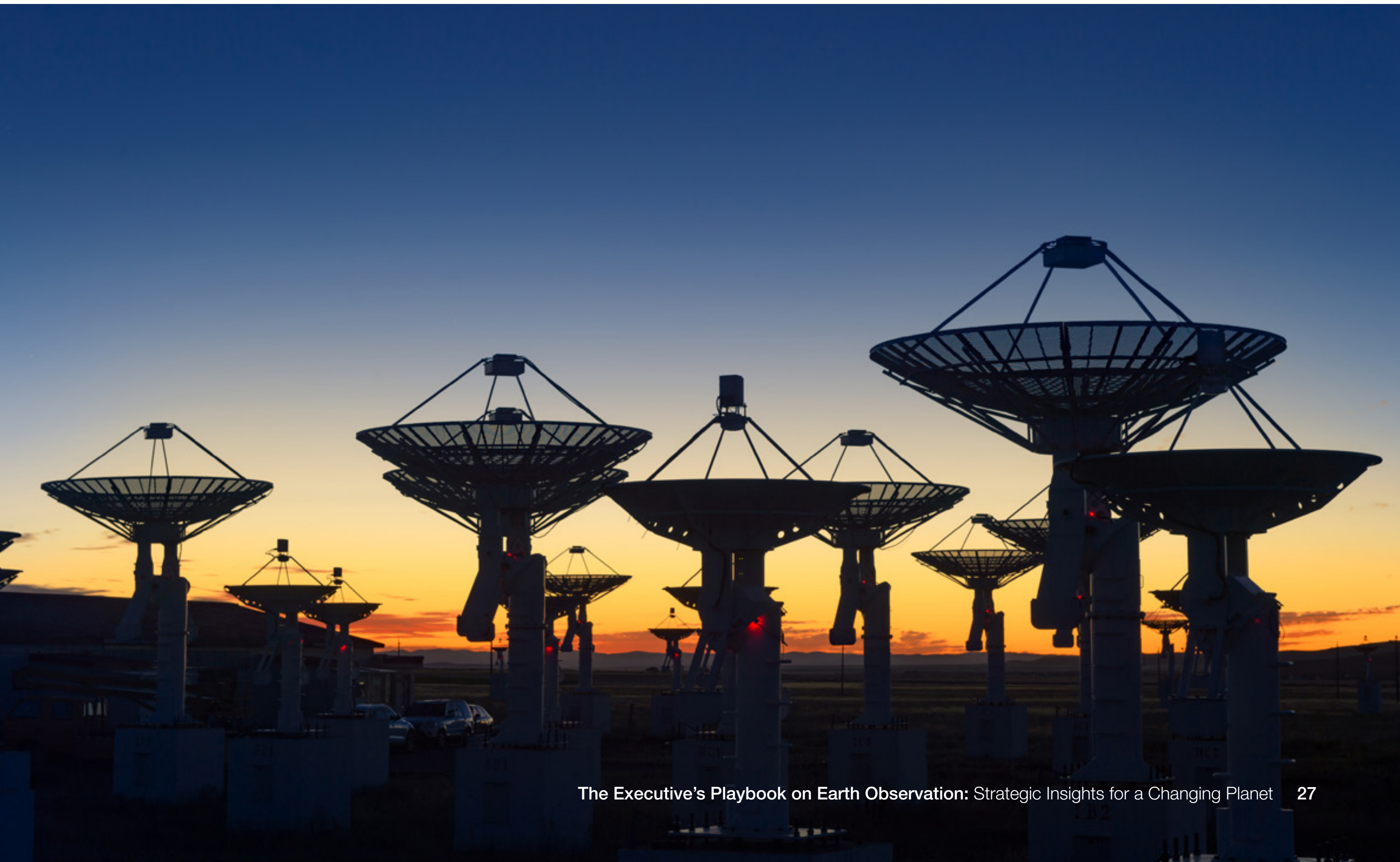
Establishing data pipelines that integrate EO data with existing platforms enables continuity in data-driven decision-making. Certain ecosystem players, like the Indian Space Research Organisation (ISRO) with its robust network of data dissemination centres, are working to make EO more easily integrated into existing systems. However, additional organization-specific work is essential to address potential obstacles such as gaps in time-series data (e.g. due to cloud coverage), by tailoring data to meet precise customer requirements and ensuring compatibility between various data sources (e.g. different spectral, temporal and spatial specifications).

Harmonizing EO data across different days and regions enables large-scale analysis, adding another layer of sophistication. The computational effort required to derive insights from a set of images is often underestimated, but with the right tools and processes, it becomes manageable. Organizations may need to implement middleware or ETL (extract, transform, load) tools that can translate EO data formats into enterprise-friendly schemas. Despite the current fragmentation of EO platforms and partial data standards, navigating through multiple interfaces and applications can be simplified, making seamless integration achievable.

Evaluating potential partnership opportunities

Implementing EO solutions may require strategic collaboration with external partners, including EO data providers, analytics firms, technology vendors, academia, research institutions, private sector entities or public agencies that offer unique datasets, deep customization, niche expertise, shared risk and lower upfront costs.

> **EO is not a commodity; selecting the right partner can significantly impact an organization's long-term success.**
>
> Bruno Sanchez, Clay



Partnerships come in several forms, each offering unique value depending on the goals and resources of the organizations involved. Here are a few prominent types when it comes to EO:

- Focus research organizations, which involve collaboration between research institutions and private companies, and drive advancements in technology (e.g. foundation models) to help solve pressing environmental issues by combining academic expertise with commercial business processes. For example, the European Organization for Nuclear Research (CERN) recently partnered with EnduroSat, NTU Athens and AGENIUM Space to apply CERN's existing AI capabilities to enable real-time data filtering onboard EO satellites.

- A classic yet powerful model, public-private partnerships (PPPs), bring together government agencies and private companies to co-develop EO solutions. These can unlock funding or access to government-led EO initiatives, reducing the burden on internal resources while enhancing the organization's capacity to focus on core business operations. For this model, within an EO context, governments often provide access to publicly funded data sources (such as from NASA or ESA satellites), while private entities offer technical expertise, data analytics and commercialization pathways. The Carbon Mapper coalition exemplifies this type of partnership. Backed by philanthropy, the coalition brings together NASA's JPL, Planet, California Air Resources Board, University of Arizona, Arizona State University and RMI – along with funders, including High Tide Foundation, Bloomberg Philanthropies and the Grantham Foundation for the Protection of the Environment, among others.

- Data-sharing partnerships focus on the mutual exchange of data between organizations to enhance EO capabilities. These partnerships can involve agreements where entities share satellite imagery, sensor data or analytical insights to create a more comprehensive dataset. Partnerships to acquire, validate and ground-truth EO data can be crucial for building reference or training datasets. This can be achieved by engaging with customers, citizen science campaigns or local universities. Moreover, organizations possessing unique datasets but lacking in EO or AI expertise can significantly enhance their capabilities. By forming alliances with specialized technology companies, these datasets can be transformed into powerful training data, thereby unlocking new potential and driving innovation.

- Consortia allow multiple organizations – often across sectors – to join forces to tackle a common goal related to EO. These consortia may focus on specific domain areas like climate resilience, renewable energy planning or agricultural monitoring, leveraging EO data.

The complexity of establishing and managing partnerships means organizations must diligently structure these collaborations for alignment on decision rights, data-sharing protocols, ownership of intellectual property (e.g. of proprietary algorithms or processing methods) and incentives (e.g. short-term output vs long-term return).

Developing a change management plan

The ingestion of spatial data may introduce new input into decision-making, organizational processes and frameworks and its successful integration requires an intentional approach to anticipate and address change. This not only involves training staff to analyse and visualize spatial data but also fostering a culture that embraces environmental intelligence and spatial data-driven decision-making.

It is also crucial for decision-makers to understand the limitations of spatial data, such as cloud cover in optical data, which can obscure important information, and low coverage or less frequent temporal resolutions, which may affect the timeliness and completeness of insights. While teams can learn how to use EO insights without becoming EO experts, organizations will likely need to build some internal capacity over time should they look to scale. Executives should invest in capacity building through trainings, workshops and partnerships, to develop EO literacy at all levels.

Measuring impact and iterating

To monitor the success of EO adoption, tailored key performance indicators (KPIs) can measure the effectiveness of EO data in achieving business and sustainability goals. These success metrics should be established early in the process and scaled appropriately to the issue being solved. KPIs could include cost savings from operational efficiencies, reductions in environmental footprint and improvements in regulatory compliance. Regular reviews of EO data performance, alongside feedback from end users benefiting from the insights, will allow an organization to adjust its strategy and continuously improve EO implementation. By iterating on successes and learning from challenges, organizations can refine their EO strategies over time, achieving long-term value.

Considering these factors enables executives to craft an EO strategy that is not only aligned with their organization's goals but is also equipped to drive lasting, scalable impact.

Conclusion

Increasingly, EO capabilities are evolving to provide insights throughout an organization; however, potential end users must remain diligent in identifying how EO can generate value for their specific contexts and follow a right-sized approach to implementation. EO is a strategic asset for organizations, transforming spatial data into actionable insights for addressing complex challenges. As economic uncertainties, environmental pressures and resource constraints intensify, EO offers a unique advantage – illuminating patterns and dependencies that inform decision-making. Thanks to its diverse industry applications, EO also presents a compelling business case, strengthening resilience, driving operational efficiency and uncovering new growth opportunities.

For additional information on how to implement EO for specific use cases, the World Economic Forum's Earth observation Use Case Library[18] can be a useful resource and provide more details on data sources, expected value and other technical considerations for specific applications of EO data.

As EO technologies evolve, so too must organizations' approaches. The path forward requires not only the ability to extract value from EO but also the capacity to remain agile and adaptive. This means continually monitoring technological advancements, evaluating new data sources and ensuring that EO continues to align with shifting business needs and external challenges.

Looking to the future, executives integrating EO in their strategic frameworks will position themselves to capitalize on emerging opportunities, respond to risks with agility and drive long-term value for their stakeholders and the environment. The adoption of EO in an organization represents a pivotal step in enhancing the organization's ability to take informed, data-driven decisions that contribute to strategic objectives. The broader adoption of EO across organizations can collectively increase capacity to better understand the Earth's systems, generating sustainable economic growth to address some of the planet's most pressing challenges.

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Endnotes

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