CEOS
Committee on
Earth Observation Satellites

Discussion Paper: CEOS Support for Adaptation and Resilience in a Changing Global Environment

Authored by the 2026 CEOS Chair Team

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CSIRO
Australia's National Science Agency

Australian Government
Geoscience Australia
Bureau of Meteorology

Image: Landsat-8, NASA Earth Observatory

This discussion paper is the product of a group of experts convened by the 2026 Committee on Earth Observation Satellites (CEOS) Chair. The document was provided for information to CEOS Principals at the 2026 CEOS Plenary (November 2026) to inform discussions around future CEOS support for adaptation and resilience.

The editorial team was led by CSIRO and Geoscience Australia (Flora Kerblat, Amy Parker, Alex Held and Maggie Arnold), with support from the Strategic Implementation Team (SIT) Chair, NASA (Eleanor Pierel and Sid Boukabara), the European Commission (Mark Dowell), and CEOS Chair Team support (Matt Steventon and Libby Rose).

Committee on
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Cover page image: Channel Country, Queensland, Australia, imaged by Landsat-9 OLI-2 on 5 March 2025. Imagery by Michala Garrison using Landsat data from USGS, published on NASA Earth Observatory. Read more: https://science.nasa.gov/earth/earth-observatory/floodwaters-surge-through-the-australian-outback-154116/

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Discussion Questions for CEOS Principals

CEOS already plays a critical role in supporting adaptation and resilience through the provision of trusted, interoperable EO data and its function of international coordination between space agencies. As environmental and societal challenges increase, the key question is how CEOS can maximize its impact.

We invite CEOS Principals to consider the questions below and reflect upon the organisation's capacity to support adaptation and resilience in an increasingly uncertain world.

1. **Where does the mandate of CEOS stop, and what should be left to national agencies, GEO or other partners?**

Survey respondents say the core mission - consistent, trusted, interoperable data - is no longer enough on its own. Should CEOS invest more directly in decision-ready products and resilience services, and how far should that go before it changes what CEOS fundamentally is? What opportunities are available for CEOS to make steps in this direction? CEOS does not own the whole value chain from mission to policy. National governments and CEOS Members were rated the top partnership priority by respondents - but drawing the line on where the role of CEOS stops is as important as the partnerships themselves. [See Section 4.1]

2. **What can CEOS improve to enable uptake of data by end users?**

Survey respondents suggested CEOS could make data more readily usable by stakeholders and describe an 'elite user bias': most EO tools still require specialist GIS or remote sensing skills. What investment by CEOS Members and Associates - in tailored products, or in intermediary partners who translate data for non-experts - would close that gap? [See Section 4.2]

3. **How can CEOS embed - and measure - its support for adaptation and resilience across its Working Groups and Virtual Constellations?**

Survey respondents flagged that the usual metrics used by CEOS - data volumes and satellite launches - say little about impact on the ground. If resilience becomes a standing objective, what outcome-based indicators should replace them, and who tracks them? [See Section 4.3]

4. **How can CEOS better showcase its impact to current and potential users facing adaptation and resilience challenges?**

Survey respondents flagged the invisibility or lack of communication about CEOS work and impact outside of immediate space and EO circles. This would explore ways (communications of outcomes and impacts) to increase CEOS visibilty to maintain trust & awareness. [See Section 4.3]

5. **What additional steps could CEOS take to ensure data and data delivery are fit for purpose in light of new technologies?**

Is there more that CEOS could do to keep up with an increasingly complex technical environment, including to integrate public/private data, support cloud processing and Artificial / Super Intelligence and Machine Learning, and better support interoperability at the mission design stage. [See Section 4.4]

1. Purpose and Scope

The 2026 Committee on Earth Observation Satellites (CEOS) Chair team, composed of Australia's CSIRO (Australia's national science agency), Geoscience Australia and Bureau of Meteorology, selected 'Adaptation and Resilience' as a Chair priority, with the objective of understanding how Earth observation (EO) and CEOS can go beyond monitoring environmental changes to better supporting regional and local communities to become more resilient and adapt to a globally changing environment. This Chair priority aligns to the 2025-2026 NASA Strategic Implementation Team (SIT) Chair priority of 'Resilience'.

This paper is intended to reflect on the current and previous role of CEOS in supporting adaptation and resilience efforts, and highlight challenges and future opportunities for CEOS. It concludes with a set of considerations in the form of questions to support a Principal-level strategic discussion at the 2026 CEOS Plenary. The paper is informed by the results of a survey that was distributed to all CEOS Members and Associates in May 2026. Fifty responses were received, representing most CEOS entities and 27 unique organisations (see Appendix for distribution).

In addition to this paper, the 2026 edition of the CEOS EO Handbook, a longstanding contribution to CEOS from the European Space Agency (ESA), addresses *Satellite Earth Observations in Support of Adaptation and Resilience*. This publication and its associated website provides context on the use of satellite EO to support adaptation and resilience, and showcases case studies that use EO-derived information to inform practical actions to adapt to changing environmental conditions across the globe. The 2026 CEOS EO handbook and all previous editions are available online (eohandbook.com).

In the context of this paper and the 2026 CEOS EO Handbook, Adaptation is defined as:

"the process of adjustment to actual or expected hazards, including evolving climatic conditions and associated impacts, in order to moderate harm or exploit beneficial opportunities."

Resilience is defined as:

"the capacity of systems - natural, built, economic, and social - to withstand disturbances, maintain essential functions, and recover efficiently under conditions of stress, uncertainty, and environmental and climatic change."

Resilience of the EO value chain

In addition to the context of adaptation and resilience used in this paper, resilience of the EO value chain was identified as a high priority for CEOS through the survey of its members. This includes ground and space-based infrastructure and systems that make data available and accessible. Key considerations are system continuity (ensuring that satellite fleets, data archives, and observation systems remain robust and operational despite external disruptions like cyberattacks, material shortages, geopolitical constraints, or data gaps); and technological evolution (the ability of CEOS to pivot dynamically to changing global priorities, new user requirements, surging data volumes, and evolving data standards and technologies). As such, the resilience of the EO value chain was brought to the agenda of the 2026 Strategic Implementation Team Technical Workshop in Washington DC.

2. How CEOS Supports Adaptation and Resilience

The core mission of CEOS is to coordinate civil space-based EO programmes and promote the exchange of data to optimize societal benefit and inform decision-making. CEOS works to improve data accessibility, usability, trust (through calibration and validation), and interoperability. In doing so, CEOS activities have enabled the creation of a robust set of tools capable of supporting preparedness, early-warning and adaptation planning, resulting in tangible support for more resilient societies. The success of CEOS lies in its effectiveness in leveraging longstanding and trusted international partnerships built between Member agencies and key partners.

Satellite EO data provides information to support adaptation and resilience across multiple time-scales, reflecting the varying timelines of different hazards. EO data supports adaptation by contributing to planning to reduce exposure to hazards and environmental change, and it can build resilience by reinforcing adaptive measures and lowering the vulnerability of populations or ecosystems, alongside verification of the effectiveness of policy interventions designed to increase resilience (see Table 1). While EO is one valuable input that impacts the capacity of society's adaptation and resilience, it is most effective when combined with other sources and capability. These include in-situ observations, predictive models, traditional and local knowledge, socioeconomic data, infrastructure information, governance frameworks, community input, and financial analysis to understand the problem, who it affects, and what actions should be taken to lower potential impact or increase resilience. When integrated with meteorological, environmental, exposure and vulnerability data, EO can generate **early-warning indicators and risk information that can support anticipatory action and thus adaptation and resilience** by enabling communities, ecosystems, agriculture and infrastructure to prepare and respond more effectively.

Short-term	Medium-term	Long-term
Disaster risk reduction and emergency response. For example, providing early warning systems, rapid damage assessment, and near-real-time intelligence for extreme events (wildfires, floods, cyclones, storm surges, and heatwaves) to minimise reaction times and save lives.	Monitoring key variables in agriculture, food and water security. For example, tracking soil moisture, forecasting crop yields, monitoring basin-level water availability, and tracking agricultural stress to help farmers and supply chains adapt to climate variability. Development of indicators and precursors for early warning. For example: realtime fire weather index, cyclone tracking and landfall estimation etc.	Risk and vulnerability assessments and infrastructure/urban planning for a resilient environment, as well as verification of the effectiveness of policy interventions. For example, mapping urban heat islands, land-use changes, and infrastructure vulnerability to guide smart city development, investment banking, and insurance risk portfolios.

Table 1: Examples of time-scales of hazards and how EO can support. More information can be found in the 2026 CEOS EO Handbook (eohandbook.com).

The EO data supplied by CEOS agencies provides objective, repeatable measurements that meet strict quality standards, with comprehensive global coverage and spanning several decades, providing the critical long-term continuity for establishing baselines and assessing changes over time. These foundational aspects underpin adaptation and resilience by providing high-quality, trusted and interoperable datasets, which have multiple impacts further downstream in decision-making pipelines such as:

- Improving disaster knowledge and recovery (speed/extent/reduced human impact).
- Increasing evidence-based monitoring, planning and policy implementation.
- Developing EO-based indicators for early warning.
- Strengthening trusted, transparent and accountable governance of environmental resources management, at every scale, providing systematic monitoring.

CEOS also draws upon its expertise across Agencies and CEOS entities to establish pilot projects that focus on thematic applications, bring together user requirements and harmonising multi-sensor datasets to demonstrate new capabilities and ways of using EO satellite data, while creating new pathways for user engagement and partnerships. Some examples include the Working Group on Climate (WGClimate)'s technical analysis of data availability based on the Global Goal Adaptation (GGA) framework, the Ecosystem Extent Task Team (now Biodiversity Virtual Constellation)'s demonstrator projects in Australia, Costa Rica and the USA, and the Working Group on Disasters (WGDisasters)'s pilots that provide tools that use satellite EO data before/after incidents and that significantly improve the user experience.

WGDisasters's pilot projects, satellite EO data coordination, and CEOS Analysis Ready Data (CEOS-ARD) were highlighted by survey respondents (who may be biased by their involvement) as the top three contributions CEOS currently makes towards society in terms of adaptation and resilience. Other contributions highlighted as being significant in supporting adaptation and resilience are shown in Table 2.

CEOS entity	Activities and objectives identified as contributing to adaptation and resilience
Virtual Constellations	• Data supply • Mission continuity • Product specifications (CEOS-ARD) • Application areas (Agriculture, Biodiversity, Forestry, Oceans, Atmosphere, etc)
Working Group Information Systems and Services (WGISS)	• Interoperability • Data access • Data preservation • Best practice
Working Group Calibration Validation (WGCV)	• Data quality and consistency • International cal/val networks • Validation protocols • Best practice

CEOS entity	Activities and objectives identified as contributing to adaptation and resilience
Working Group Climate (WGClimate)	• Climate data records gap analysis • Stakeholder engagement
Working Group Disasters (WGDisasters)	• Pilot projects and demonstrators • Recovery Observatory • Data coordination for the Geohazard Supersites and Natural Laboratory initiative (GSNL)
Working Group Capacity Building and Data Democracy (WGCapD)	• Training and capacity building (including calendar) • Earth Observation Training, Education and Capacity Development Network (EOTEC DevNet)
Cross-cutting	• Earth Observation Handbooks • Global Stocktake Study Team Report • Sustainable Development Goals (SDGs) oversight • Missions, Instruments and Measurements (MIM) Database

Table 2: CEOS activities identified as contributing to adaptation and resilience.

3. From Data to Decisions: the Link Between CEOS and Downstream Users

Whereas CEOS operates towards the upstream end of the EO data value chain, adaptation and resilience users often work at the far downstream end. CEOS members surveyed recognise the importance in transforming upstream (closer to 'raw') EO data into validated, trusted, and decision-ready insights, and that it is increasingly important for CEOS to not only guarantee continuity of high-quality accessible satellite data, but also to facilitate timely uptake by users.

Examples of how CEOS works on adaptation and resilience include:

- Working effectively with partner agencies to ensure users and decision makers have the data and information they need. Survey respondents identified National Governments as the highest priority partner (selected by 67% of respondents) in the efforts of CEOS to support adaptation and resilience, followed by CEOS Members and Associates (selected by 60% of respondents). Other key partners included multi-lateral bodies, such as UN bodies and the inter-governmental Group on Earth Observation (GEO), and commercial data providers. This highlights a natural role for CEOS as a coordinating body through which a common voice (both for technical standards, and advocating for the use of EO) is developed, which can then be shared through agencies to national delegations.
- Established mechanisms to enable external parties to formally seek guidance and technical support from CEOS with their satellite data requirements, based on users' needs analysis and CEOS Agency missions data availability (the 2020 'External Requests Process Paper').

- Through WGCapD, increasing the capacity of institutions in less developed countries to effectively use EO data through, unifying CEOS efforts towards data accessibility and the sharing of software tools, and providing intensive capacity building, education, and training. In turn, this supports these communities in applying EO to national and localised adaptation and resilience building, which has become fundamental to demonstrate impacts of CEOS Members investment in satellite missions.

Many survey respondents identified 'decision-ready' products as an opportunity for CEOS to go beyond its long and well-established role in supporting adaptation and resilience by leading on the improvement of data accessibility, usability, trust and interoperability. This raises a question about the mandate of CEOS and what CEOS can realistically support without overstepping into the policy-making or legislative remit of other international organizations.

As a best efforts organisation, CEOS needs to consistently remain aware of changing priorities and resources not just of its own Members but of partner organisations who may also change focus and scope over time affecting joint outcomes.

Case Study: CEOS Support for the United Nations Sustainable Development Goals (SDGs)

The SDGs have been a strategic priority for CEOS over the past decade (e.g. 2018 CEOS EO Handbook on the SDGs) and a flexible approach was adopted to align the priorities of GEO (far downstream end users) with the work of the different CEOS entities (up- to mid-stream). This successfully enabled CEOS to strengthen partnerships with SDG stakeholders (e.g. UN bodies, National Statistical Offices) and to promote the value of EO to a wider audience of end-users. The CEOS "EO Support Sheets" were produced to demystify complex SDG reporting frameworks and to provide step-by-step guidance and lists of resources to support the integration of EO-based products into decision making processes for 4 SDG Indicators. The CEOS team's achievements were recognised by the EO community by winning a GEO SDG Award in recognition of their accomplishments in promoting the value of satellite data and the provision of useful material (including technical user guides) to increase and enhance satellite data access and uptake. The CEOS work on SDGs evidenced the challenges in addressing such a broad and complex issue within the current internal governance structure, while highlighting the benefits and impact, for the specific indicators addressed, when CEOS' competences and capabilities were well linked with external entities developing the direct interface to the users.

4. Opportunities for CEOS to Better Support Adaptation and Resilience

Adaptation and resilience are priorities of the national governments of the majority of surveyed CEOS members (78% agree or strongly agree), yet **many members reported believing CEOS could do more to ensure the potential of EO for adaptation and resilience is realised**. Based upon analysis of feedback collected in the survey and CEOS SIT discussions, there are a number of opportunities identified for CEOS Principals to consider for defining the next steps.

4.1. Curating needs and requirements

Related Discussion Question

1. Where does the mandate of CEOS stop, and what should be left to national agencies, GEO or other partners?

CEOS has an established process (the 2020 'External Requests Process Paper') for external organisations to request guidance and technical support to analyse their satellite data needs.

Initiatives such as GFOI and GEOGLAM have successfully engaged with CEOS to identify essential variables, by aligning community priority needs with available and planned satellite EO datasets, and highlight observation gaps. This iterative approach also benefits CEOS Agencies to shape future missions (e.g. priorisation) and improve data uptake.

While these are examples, many other communities, including those focused on water quality, land degradation, and biodiversity, would benefit from a clearer and more efficient mechanism to define and communicate their satellite EO data requirements.

To streamline the process, CEOS should continue to work closely with organizations such as WMO (who is an Associate member of CEOS) to leverage existing 'Data Analysis and Requirements' activities (noting they are not fully end-to-end), and build bridges to help community users meet their needs more efficiently.

4.2. Strengthening Downstream Uptake of CEOS Data

Related Discussion Question

2. What can CEOS improve to enable uptake of data by end users?

The survey findings suggest that CEOS should continue strengthening its core coordination activities, while considering how it can better support the integration of EO data into decision-making processes through stronger partnerships, reducing barriers to entry, increased capacity development, and user-focused services.

Some survey respondents see an opportunity for CEOS to pivot towards an increased focus on decision-ready information, but this must be carefully balanced against the existing mandate and resources of CEOS. The survey respondents identify the urgent need to reassess training and capacity building resources for CEOS to make a stronger impact in the global EO community, as well as in regional and local communities. This could imply strengthening the role of WGCapD (extra resources, alignment with CEOS strategic objectives), or allocating dedicated resources to activities within CEOS to tackle strategic and well-defined objectives that would support the systematic development of indicators that would inform and serve multiple agenda/decision purposes. Linkages with other multilateral fora who have capacity building and outreach as their mandate, such as some UN bodies, GEO, WMO, etc., could also be strengthened to ensure efficient use of time and resources and to ultimately identify the handover point to other 'operational' bodies at an appropriate time.

4.3. Measuring and Showcasing the Value of CEOS Activities

Related Discussion Questions

3. How can CEOS embed - and measure - its support for adaptation and resilience across its Working Groups and Virtual Constellations?
4. How can CEOS better showcase its impact to current and potential users facing adaptation and resilience challenges ?

Increased global coordination, data harmonisation and validation, and technical integration are essential to maximise the societal benefits of EO capabilities. These core CEOS activities require sustained institutional resources that are often less visible than a satellite launch but are entirely vital. However the link between these activities and, for example, parametric insurance payouts or evidentiary standards for environmental law - some of most non-traditional yet most compelling examples of EO impact - are often invisible so not well recognised. Survey respondents strongly voiced that the immense contributions of CEOS are often unrecognized. For instance, the critical role of CEOS in delivering the GEO Work Programme has long been recognised (CEOS-GEO used to hold annual bilateral meetings, reflecting the unique position of CEOS among GEO Participating Organizations as the 'Space Arm' of GEO). While the CEOS-GEO relationship has evolved, many of GEO's achievements, including GFOI, GEOGLAM, EO4SDG, and GEO LDN, have relied and still heavily rely on the leadership and contributions of CEOS agencies. Due to the cross-pollination of subject matter experts and close coordination between CEOS and GEO, the two groups may benefit from revisiting communication around collective impact as partners.

There is an opportunity for CEOS to communicate its added-value and impacts to decision makers and adjacent agencies much more clearly. The majority of CEOS members surveyed indicate that decision makers in their context are persuaded more by practical examples/case studies than technical performance metrics (76% agree or strongly agree), and so collecting these examples, in addition to defining some way to measure the impact of CEOS, is key. The 2026 CEOS EO Handbook is a significant contribution providing an evidence basis, however promoting this product more extensively outside of the space/EO sector (eg. in other non-technical communities) would help to emphasize CEOS impact in supporting adaptation and resilience. Exploring how to leverage this resource to maximise CEOS impact beyond the 2026 Chair year is critical (e.g. research papers, non-EO conferences, inputs to national plans, etc.)

4.4. Technical coordination that continues to be fit for purpose

Related Discussion Question

5. What additional steps could CEOS take to ensure data and data delivery are fit for purpose in light of new technologies?

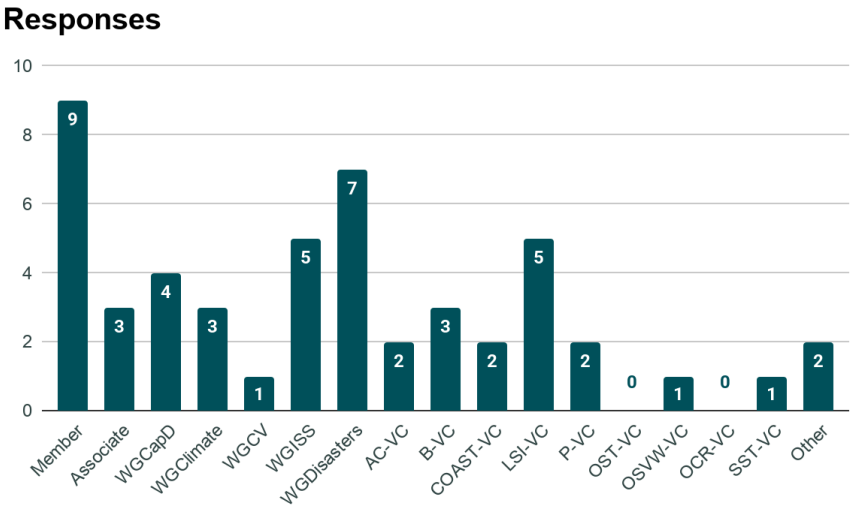
The role of CEOS in delivering consistent, interoperable and trusted satellite EO data on a global scale over time is critical in support of adaptation and resilience. As upstream and downstream

EO technologies grow increasingly complex, the focus of the technical coordination done by CEOS should evolve accordingly. Examples include:

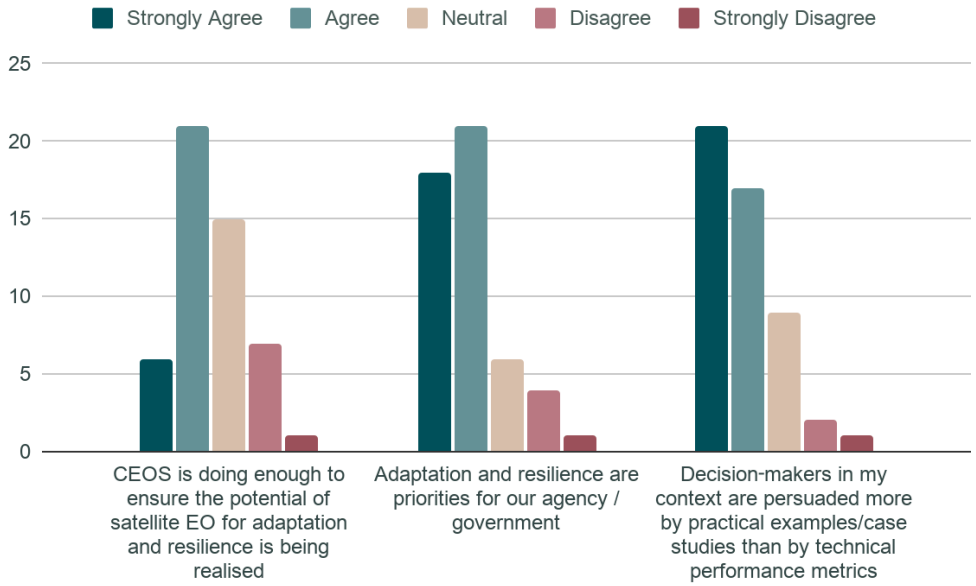
- Integration of public and commercial capabilities (e.g. higher resolution data for local/scale adaptations), blending public open-science data with private high-resolution data to set the standard for how mixed sources can be utilized seamlessly for global public safety.
- Readiness for data to be used with new technologies such as cloud-native processing and Artificial / Super Intelligence and Machine Learning.
- Implications and impacts of Artificial / Super Intelligence on CEOS data and activities.
- Prioritisation of Artificial / Super Intelligence and Machine Learning readiness, interoperability and Analysis Ready Data (ARD) at the mission-design phase (intersection with FutureARD Strategy).

Appendix: Survey Responses

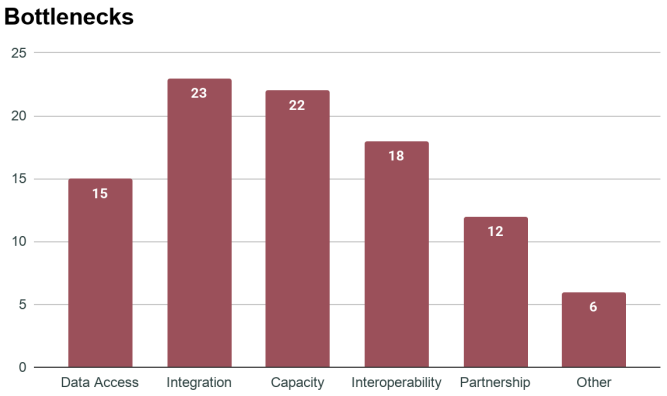
The survey received 50 responses, from 27 unique organisations.



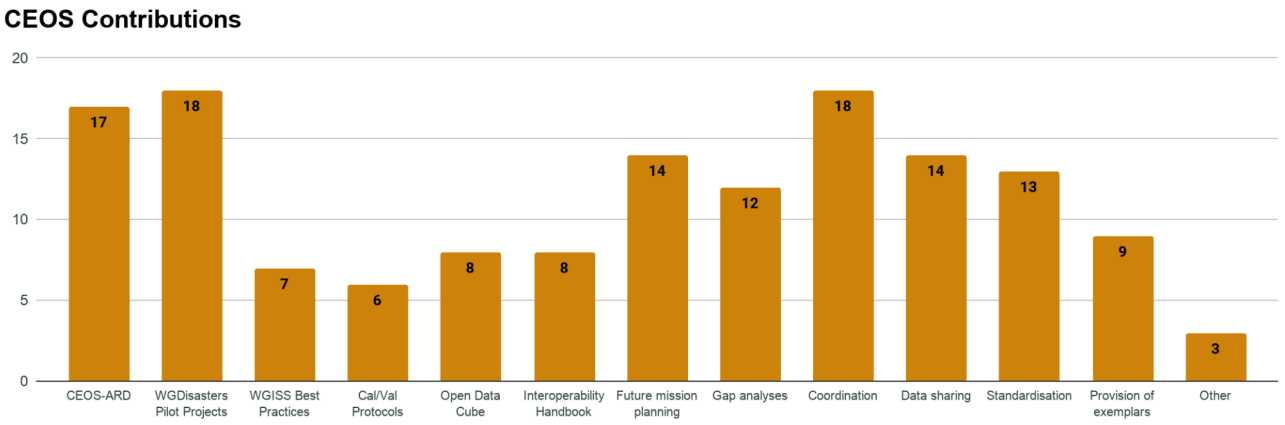
Survey respondents were asked to rate how they agreed with three statements. The results are shown below.



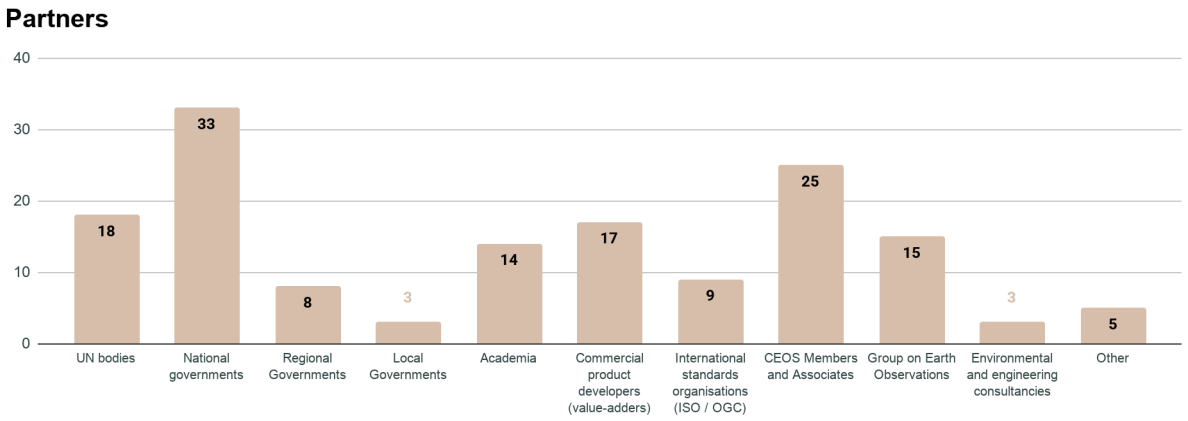
Integration and capacity were highlighted as the main bottlenecks to delivering impact from satellite EO for Adaptation and Resilience.



Respondents were asked to pick the top three contributions from CEOS to Adaptation and Resilience. The list of contributions was pulled from the discussion held at SIT-41.



Respondents were asked to pick the top three critical partners in the efforts of CEOS to support adaptation and resilience.



Survey respondents also provided a number of additional resources to support the development of this paper, which can be found grouped below into four themes:

- **Missions/Programmes**:
  - ESA's OpenEO: https://openeo.cloud/
  - European Climate Data Explorer: https://climate-adapt.eea.europa.eu/en/knowledge/european-climate-data-explorer
- **Application Examples**:
  - Global Nature Watch: https://www.globalnaturewatch.org/
  - USGS WaterMAP: https://apps.usgs.gov/watermap/
  - Geohazard Supersites and Natural Laboratories (GSNL): https://geo-gsnl.org/
- **Training, Capacity & Community building**
  - Disaster Risk Management workshop in Catalonia: https://www.youtube.com/watch?v=7W3m9hv5PoA
  - IEEC Workshop 'Space technologies for security: risk management in natural disasters': https://www.ieec.cat/en/come-to-the-benchmark-event-on-the-use-of-space-technologies-for-natural-disaster-risk-management/
  - EURISY Workshop 'Satellite-based Services for Disaster Risk Management in Spain' https://www.eurisy.eu/event/satellite-based-services-for-disaster-risk-management-spain/about/
  - TerraWatch Newsletter: https://newsletter.terrawatchspace.com/
  - NASA ESD Industry Summit: https://doi.org/10.5281/zenodo.19372308
- **Policy Impact**
  - UN Global Compact – Accenture 2025 CEO Study: https://info.unglobalcompact.org/ceo-study-2025
  - IPCC Sixth Assessment Report, Working Group II https://www.ipcc.ch/report/ar6/wg2/
  - Lazarus, Richard J., ""Super Wicked Problems and Climate Change: Restraining the Present to Liberate the Future"" (2009). Georgetown Law Faculty Publications and Other Works. 159. https://scholarship.law.georgetown.edu/facpub/159
  - Publications by Conservation International (CI): https://geo-ldn.org/publications-by-conservation-international-ci/