Adoption and Impact of Earth Observation for the 2030 Agenda for Sustainable Development

Executive Summary

Commissioned by the European Space Agency

Caribou Space for Development

esa

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Foreword by ESA Director of Earth Observation Programmes

This report is the result of a close and productive collaboration between ESA and some of the key International Financial Institutions (IFIs) over the last decade. Together with the World Bank (WB), the Asian Development Bank (ADB), and the International Fund for Agricultural Development (IFAD), ESA have been evaluating the benefits (quantitative and qualitative) that satellite Earth Observation (EO) can deliver to development assistance in the framework of operations carried out in the developing countries. The report highlights both the use cases and development outcomes and impacts of satellite Earth Observation (EO) – from both ESA and additional organisations and initiatives.

Satellite Earth Observation (EO) provides a wide range of different types of environmental information that are global, comprehensive, accurate, repeatable and timely, and that are key to the effective planning and implementation of development assistance activities. In addition, Europe brings world-leading EO capabilities; both in terms of space missions (EU Copernicus, ESA, EUMETSAT, European National missions), and in terms of diversity of specialist products and services available through the downstream geo-information sector. In particular, Copernicus marks the beginning of a new era in Earth Observation with the Sentinel satellites now being launched as the basis of operational environmental information services and unprecedented volumes of data with long-term continuity to 2030 and beyond.

This initial collaboration has raised significant interest of these and other stakeholders in the development community to scale-up and mainstream the use of EO-based information in the longer-term. To achieve this ambitious goal, a joint initiative has been agreed in which ESA carry out the required technical developments, and the World Bank together the Asian Development Bank carry out complimentary activities (Capacity-building, Skills Transfer) using their own financial resources (Official Development Assistance Trust Funds) in an integrated programme of work called "Space in Support of International Development Assistance". I am very pleased to say that this highly innovative joint initiative is now underway with the ESA component financially supported by 13 Member States at the Space19+ in November 2019, and the WB and ADB components being brought into place this year through new dedicated Trust Funds (accredited by the Organisation for Economic Development - OECD).

The extraordinary period that we are experiencing now is a powerful demonstration that we live in world increasingly subject to major environmental, climatic, economic and social challenges. The 2030 Agenda for Sustainable Development is an action plan to take the bold and transformative steps that are urgently needed to shift the world onto a sustainable and resilient path. Therefore, in this context, we very much look forward putting EO technology to work in addressing some of today's grand societal challenges and to improve development assistance efficiencies and impact through wide-scale, long-term sustainable use of EO-based environmental information.

Dr Josef Aschbacher
Director of Earth Observation Programmes
European Space Agency

Background

This report was commissioned by the European Space Agency (ESA). ESA is an intergovernmental organisation of 22-member states whose mission is to *"shape the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world"*.[1]

Since 2010, ESA has been working with various International Financial Institutions (IFIs)—including World Bank (WB), Asian Development Bank (ADB), European Investment Bank (EIB), Inter-American Development Bank (IADB), International Fund for Agricultural Development (IFAD), and the Global Environment Facility (GEF)—through the ESA Directorate of Earth Observation Programmes (EOP) and, specifically, through the Earth Observation for Sustainable Development (EO4SD) initiative.[2] EO4SD's objective was to promote the integration of satellite information products and services, as best-practice environmental information, in the planning and implementation of IFI development activities together with their respective developing country partners.

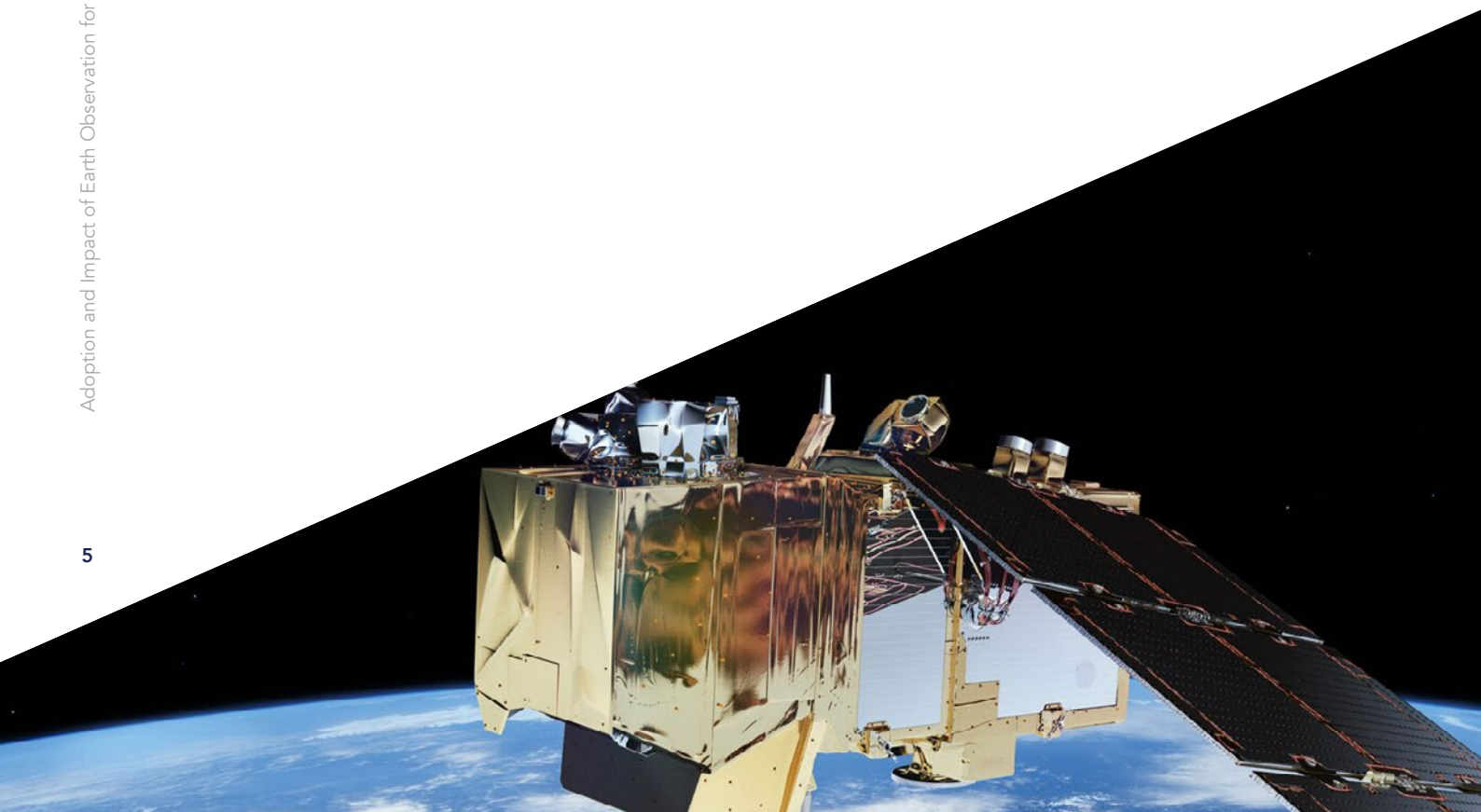
ESA is preparing a new joint initiative in partnership with WB & ADB, "Space in Support of International Development Assistance" (Space for IDA), in 2020. This initiative will extend and expand the efforts of EO4SD with a mission to *"Realise the full potential impact of environmental information from satellites in addressing core development challenges through transfer and mainstreaming into development assistance operations, activities and financing"*.

This report aims to capture and communicate the evidence of the use cases and impact of Earth Observation (EO) in sustainable development for select sectors including agriculture, forestry, disaster resilience, urban development and climate resilience. The impact findings are primarily drawn from practical case examples in public domain literature and also based on interviews. The literature review used in this report prioritises evidence on EO use cases and impact for developing countries. However, in some areas limited information is available, and accordingly, examples from developed countries are used as needed.

1 European Space Agency. 'United Space in Europe'. https://www.esa.int. Accessed February 2020.

2 European Space Agency. 'Earth Observation for Sustainable Development'. http://eo4sd.esa.int/. Accessed February 2020.

The research findings within this report are expected to be of value to organisations in the development community who are interested in learning about the various use cases and impacts of integrating EO to advance their development. The audience is donors, IFIs, developing countries, national space agencies, and the broader development community e.g. NGOs. Whilst there are benefits arising from other aspects of space capabilities to the field of sustainable development (e.g., satellite communications (SatComms), global navigation satellite system (GNSS), space weather/meteorology), this report focuses on benefits arising from using EO as a unique and powerful source of environmental information.



Executive summary

What is sustainable development?

- Sustainable development is "*development which meets the needs of the present without compromising the ability of future generations to meet their own needs*".
- The World Bank's World Development Report 2003 argues that "*Unless the transformation of society and the management of the environment are addressed integrally along with economic growth, growth itself will be jeopardised over the longer term*".
- The UN 2030 Agenda and the Sustainable Development Goals (SDGs) provide a globally agreed set of development priorities and targets to 2030.
- Accurate, global, and timely data is critical to tracking progress towards the achievement of the SDG targets and indicators, and Earth Observation (EO) can contribute to the measurement of 34 SDG indicators.
- Whilst the SDGs provide an overarching and globally agreed set of priorities, donors and IFIs provide customised assistance addressing individual developing countries' and local stakeholders' individual challenges.
- Developed countries support the economic, environmental, and social development of developing countries via their Official Development Assistance (ODA) budgets.
- Major global trends affecting development assistance include concerns on the environment and climate change and also the impact of advancing technology and innovation.
- For development assistance, robust data is the foundation for meaningful policymaking, efficient resource allocation, and effective public service delivery but widespread 'data deprivation' exists.
- Digital technologies—particularly the trinity of satellites, smartphones, and sensors can close this "data deprivation" gap by providing an increasingly detailed view of the world in which we live.

Using Earth Observation data for sustainable development

- Earth Observation (EO)—the process of gathering information about the physical, chemical, and biological systems of the planet via remote-sensing— provides unique datasets that enhance sustainable development programmes.
- Europe's Copernicus programme is the most comprehensive EO programme and is a game changer in providing an unprecedented volume of open access EO data – with operations secured for the coming decades.
- EO has global coverage including remote or conflict regions, it is diverse, affordable, objective, repeatable, continuous, and timely to acquire and process.
- EO is particularly powerful in data-scarce developing countries complementing other sources of data such as census, bespoke surveys, ground teams, or drones.

Benefits of Earth Observation for development assistance organisations

Donors and IFIs share similar multi-phase processes for designing, mobilising, delivering, and closing/evaluating their programmes, and EO can support these phases:

  - EO facilitates improved policy definition and planning of future activities in the 'Design' stage,
  - EO improves the efficiency of existing operations and activities, leading to increased impact in the 'Delivery' stage, and
  - EO provides increased transparency, objectivity, and accountability in the 'Evaluation and Closure' stage by enhancing M&E capabilities.

- In addition, across all these programme delivery phases EO provides new and extended capabilities that allow donors and IFIs to tackle issues they could not previously address e.g. dealing with the complexity of climate resilience.
- Digital economies create benefits and efficiencies as digital technologies drive innovation, fuel job opportunities and support economic growth.
- Expansion of the EO services sector, as part of the digital economy in developing countries supports growth of local economies.

Impact of Earth Observation in agriculture

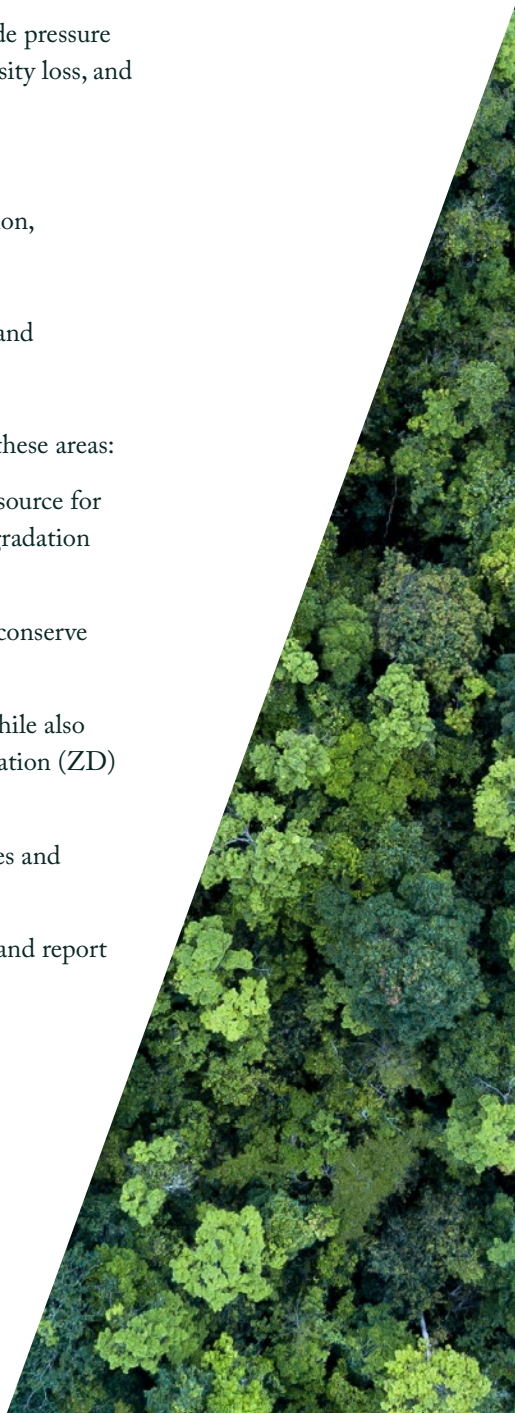
- The developing world agriculture sector faces many challenges, including lower production yields, ongoing food security concerns, growing populations, unsustainable use of natural resources, and climate change leading to unpredictable and extreme weather patterns.
- EO provides benefits within agriculture in five overarching areas:

  1. Increasing agricultural production through accurate decision support tools,
  2. Supporting sustainable management of environmental resources,
  3. Optimising supply chains to reduce losses and improve food security,
  4. Increasing accuracy of flood and drought warning systems, and
  5. Ensuring affordable credit for farming inputs and insurance for crop/livestock losses.

- Several insights from public literature have contributed evidence to each of these areas, for example:
  - EO has been used to provide cost-effective information that supports decisions at key points in crop cycles, optimises production, improves disease and pest response, and enables the restoration of wasteland to productive land.
  - EO has proven use cases in resource management and has been shown to reduce waste (of water, fertilisers, and pesticides), reduce costs, and improve yields.
  - EO has been incorporated into national food security monitoring and has improved government planning.
  - EO-based services to deliver credit and insurance were shown to be timely, cost effective and deliver financial support in times of need.
  - There is limited public domain evidence of EO use for reducing supply chain losses, but this represents a clear opportunity for EO.

Impact of Earth Observation in forestry

- Forests in the developing world face a wide range of challenges. These include pressure for conversion to agricultural land, illegal deforestation, habitat and biodiversity loss, and deprivation of livelihoods for forest-dependent communities.
- EO provides benefits within forestry in four overarching areas:
  1. Supporting mapping and monitoring of deforestation and forest degradation,
  2. Supporting precision forestry,
  3. Providing resilience to natural disasters such as fires and floods in forests, and
  4. Aiding local forest populations.
- Several insights from public literature have contributed evidence to each of these areas:
  - EO has been used in global platforms for forest monitoring and as a data source for UN SDG 15 and Reducing Emissions from Deforestation and Forest Degradation (REDD+) reporting.
  - EO has been used to support forest governance, deter illegal logging, and conserve high-carbon forestry stocks.
  - EO has been applied as a cost-effective solution to optimise forest yield while also acting as an accountability tool for corporations to adhere to zero deforestation (ZD) commitments.
  - Numerous cases have demonstrated EO capabilities in detecting forest fires and improving emergency response.
  - Local forest populations have used EO to secure land rights and monitor and report illegal or harmful practices.



Impact of Earth Observation in disaster resilience

- Developing countries are highly impacted by disasters. Infrastructure and buildings may not be as resilient, disaster response procedures may be less sophisticated; moreover, low-income populations are exposed to hazards more often, lose a higher share of wealth, and receive less support from financial systems and governments.
- EO provides benefits within disaster resilience in three overarching areas:
  1. Improving the accuracy and extent of disaster early warning systems,
  2. Supporting near real-time monitoring for better planning and prioritisation in disaster response, and
  3. Improving resilience via insurance through better risk calculation.
- Several insights from public literature have contributed evidence to each of these areas:
  - There is evidence of early warning systems becoming more effective using EO, particularly for weather related events. This allows for timely activation of emergency plans, which reduces the number of deaths and missing persons as well as economic losses.
  - EO use was shown to support a more coordinated and targeted disaster response, for floods, hurricanes, and earthquakes.
  - The use of EO has been demonstrated to enhance existing insurance schemes and support disaster-risk financing mechanisms. It is expected that this use case will grow, considering the urgent need to insure risk in the face of climate change.

Impact of Earth Observation in urban development

- Cities need evidence-based plans to understand the city fabric and prioritise investment. But obtaining relevant, scalable data is a significant challenge for many developing world cities.
- EO provides benefits within urban development in four overarching areas:
  1. Urban planning and monitoring,
  2. Transport planning and monitoring,
  3. Hazard assessment, early warning, and response coordination, and
  4. Monitoring of environmental issues.
- Several insights from public literature have contributed evidence to each of these areas:
  - There is evidence of EO being integrated into city plans, slums assessments, and innovations using EO to resource their development plans by improving tax revenue.
  - Examples of EO used in transportation planning and monitoring exist, primarily in developed countries, but also more recently from developing countries.
  - Evidence on the benefits of EO for disaster risk assessments and efficient response is plentiful. In addition, there are EO applications to assess urban building/infrastructure risk exposure (see Impact of Earth Observation in disaster resilience section, above).
  - Innovations in satellite sensors enable the measurement of air quality and surface temperature to provide cities with critical environmental information that can be used to support sustainable development interventions.

Impact of Earth Observation in climate resilience

- Climate change presents the single biggest threat to development, and its widespread, unprecedented impacts disproportionately burden the poorest and most vulnerable people in developing countries.
- EO can provide key inputs to understanding the potential relationships of previously un-modelled (and not intuitive) dependencies between physical climate change and social outcomes.
- EO provides benefits in these overarching areas:
  1. Measuring the state of the climate through Essential Climate Variables (ECVs),
  2. Providing indicators for climate change risk assessments,
  3. Monitoring and building resilience to slow-onset climate change events e.g. sea level rise, and
  4. Monitoring and building resilience to rapid-onset climate change events (i.e. extreme weather events).
- Several insights from public literature have contributed evidence to each of these areas, for example:
  - ECVs address public demands for transparency in environmental decision making and have helped many nations to make commitments to support systematic, sustained climate records. ESA uses EO to produce ECVs through its Climate Change Initiative programme.
  - There is evidence of EO being used to monitor slow-onset climate change events where the repeatable, historical time series of data allows the analysis of long-term trends – including numerous examples for assessing sea level rise and coastal flooding risk.
  - There is extensive evidence of use of EO for rapid-onset climate-related events such as tropical cyclones – see Impact of Earth Observation in disaster resilience section.

Earth Observation uptake and barriers for donors and IFIs

- Donors particularly in Europe, have been flagbearers for the adoption of EO in sustainable development.
- In parallel, ESA has supported IFIs adoption of EO since 2010.
- The main barriers to expanding the wider use of EO in sustainable development are referred to as the 'five As':
  - The (1) Availability and (2) Accessibility barriers are currently being addressed by existing European programmes, including the Copernicus space component and the Copernicus Data and Information Access Services (DIAS).
  - The (3) Awareness, (4) Acceptance, and (5) Adoption barriers will be addressed by a new joint initiative between ESA, WB and ADB—Space in Support of International Development Assistance (Space for IDA).

Recommendation one: Close impact evidence gaps with robust monitoring & evaluation (M&E)

- Across multiple sectors and within various EO use cases, encouraging and positive evidence on benefits of EO within sustainable development have been highlighted.
- Some sectors have a longer history with using EO and therefore have more mature evidence bases. However, this is use case specific.
- New use cases for EO are emerging more quickly than the publication of corresponding impact evaluations. Both time and commitment of resources are needed for measuring the impact of EO.
- In programmes that are integrating EO as a core data source, a robust M&E system that both articulates and can evaluate the impact of EO within the sustainable development sector should be established at the start of the programme.
- Impact evaluations should communicate and quantify the benefits of EO—using language and statistics that the development community are familiar with.
- It is recommended that impact evidence be widely shared so that others can benefit from these lessons and results

Recommendation two: Need for the Space for IDA initiative to transfer and mainstream EO into development assistance

- The primary objective of Space for IDA will be to "*Realise the full potential impact of environmental information from satellites in addressing core development challenges through transfer and mainstreaming into development assistance operations, activities and financing*". The initiative will have three activities designed directly to address the barriers identified above:
  - **Activity 1: Knowledge Development (ESA-led)**: Co-develop demonstration materials and do risk-reduction technical developments for less well-established EO product types.
  - **Activity 2: Capacity Building (IFI-led)**: For IFIs, donors, private foundations, and developing countries in the use of EO in operations; co-design and develop methodologies and guidelines.
  - **Activity 3: Skills/Knowledge Transfer (IFI-led)**: Expertise and capability transfer programme for EO production and analytics in developing countries.
- The initiative will be implemented in a joint, coordinated programme of work between ESA and newly established Trust Funds at WB and ADB.
- The estimated budget will be between US$80-100 million for the WB and ADB led components.
- 13 ESA member states have provided initial financial commitments of €30 million and the objective to initiate implementation from 2020 to 2025.
- This initiative will also help in assessing and responding to Covid-19 by allowing remote management and monitoring of development activities, and by providing information that helps better formulate both social protection and economic recovery measures.

Caribou Space supports organisations to bridge the space and sustainable development worlds by working with governments, space agencies, development agencies, and private sector space companies. Caribou Space provides:

- **Official Development Assistance (ODA) fund and programme strategy**: Strategic recommendations for the design and delivery of ODA programmes.
- **Fund management**: Large scale ODA funds (£100 million plus), and seed stage funds (£4 million plus).
- **Monitoring and Evaluation (M&E)**: Design of M&E systems, delivery of process and impact evaluations, and M&E training.
- **Research, communications, and knowledge sharing**: Conducting research on market opportunities, user needs, use cases, and impact of space solutions, and publicly sharing knowledge of what works, doesn't work, and why. Using diverse communications channels including press and media, publications, social media, conferences and workshops.
- **Programme management**: Delivery of complex, multi-country, multi-million-pound programmes in developing countries.
- **Product strategy**: Supporting strategy for the sustainability and commercialisation of space solutions for developing countries.
- **Economic evaluation**: Quantification of the economic case and impacts of space technology.

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