Evaluation of Earth Observation for Sustainable Development (EO4SD)

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Executive Summary

European Space Agency (ESA) EO4SD has an overall objective to start the integration of satellite information products & services, as 'best-practice' environmental information, in the planning and implementation of the development projects, programmes and activities of the International Finance Institutes (IFIs), together with their respective Client States (CS).

This Rapid Assessment provides an evaluation of the progress, results and lessons from the current EO4SD programme focused on the Urban Development, Agriculture & Rural Development and Water Resources Management projects. The evaluation is aligned to the OECD DAC Criteria for Evaluating Development Assistance – to assess EO4SD's Relevance, Effectiveness, Efficiency Impact and Sustainability.[1]

Relevance: The three projects are well considered and relevant for the programme objectives in terms of their scope of outputs e.g. Earth Observation (EO) products, geographies and partners.

However, consortium partners have identified that greater flexibility in the ESA Statement of Work (SOW) could have led to better designed product portfolios.

Effectiveness: There is very strong focus on delivery of the projects, and specifically technical delivery and validation of the project EO product portfolios, utilising the combined EO technical expertise of ESA and the consortiums. This has led to broad achievement of each project's objectives (i.e. the Work Requirements) with only minor delays (~3–5 months across 3 years).

However, consortiums highlighted differences between the ESA SoW and the IFI/CS actual user requirements, overlaps between different EO4SD project's scope, need for more senior level IFI engagement and difficulty aligning to IFI programme timelines – as areas to be optimised to maximise effectiveness. Also, the risk of 'user fatigue' due to overlapping demands across EO4SD projects and non-ESA programmes was highlighted.

Efficiency: The consortiums utilise many mechanisms to minimise their costs and to achieve an efficient use of the budgets and resources. Given the €25 million budget, there is a very large volume of activity underway across EO4SD in terms of number of thematic domains, countries, IFI and CS partners, consortium members and EO products.

However, as there is no formal 'Value for Money' assessment in scope (e.g. cost-benefit analysis or cost-effectiveness analysis) it is hard to quantitatively assess efficiency of use of budgets and resources. The consortiums highlighted the need for increased alignment of project and IFI timelines, the need for greater flexibility in the SoW deliverables and optimising documentation and reporting overhead to maximise efficiency. Also focusing resources heavily in exemplar 'lighthouse' countries that can act as a guiding example to neighbouring countries that have the same issues.

Impact: The direct project beneficiaries are the IFI and CS stakeholders, and an assessment of the short-term development outcomes for these stakeholders has been provided for each EO4SD project later in this report. The longer-term outcomes on the indirect beneficiaries[2] are less well defined and are not within the current EO4SD consortium's scope to measure.

1 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed November 2018.

2 Those living within the zone of influence of the project e.g. the city population, local farmers, or people living near to a river system.

It is suggested to consider maximising future impact by ensuring IFI and CS users have multiple IT mechanisms to access EO products, increased support for ground truthing resources to calibrate EO products and ESA investing in public domain EO products for specific domains. Increasing the focus and budget for impact evaluations would improve the assessment of long-term development outcomes and impacts.

Sustainability: There are extensive and effective capacity building efforts for IFIs and CS. Additionally, the public communications (knowledge sharing) mechanisms are excellent, including a website hosting product catalogues, public case studies, webinars, EO data portals and distance learning courses.

However, consortiums have identified that whilst EO has been 'demonstrated' as best practice environmental information, to 'integrate' it in the 'planning and implementation of the development projects…' will require a long-term push from ESA and sustained engagement of IFI senior management – which ESA's Space for International Development Assistance (Space for IDA) is designed to deliver. Also highlighted is the need to focus ESA support on 'EO Regional Expert Centres' in CS that have the mandate, and technical expertise and infrastructure to adopt and mainstream EO products.

— *Conclusions*

From the assessment it is clear that EO4SD is a well-designed and executed programme. The experience and lessons of partnering with IFIs in Phase 0 (2010-2015, €8 million) have clearly been incorporated into the strategy and design of the current phase. ESA is proven as a capable organisation in delivery of an EO programme within a development context. The ability to bridge the capabilities and complexities of both the space and the development sectors, developed over many years working with the IFIs, will prove invaluable in the design and execution of Space for IDA.

This evaluation identifies lessons (see Table 0) which are entirely manageable inside the current EO4SD programme. However, as ESA scales up from €25 million to ~€200 million, these issues would amplify and therefore would benefit from correction. We have provided tactical, actionable, recommendations for both the existing EO4SD and future Space for IDA programme for discussion and review with ESA. We recommend these lessons, or their improved variants following ESA review, are systematically incorporated in the setup and design phase of Space for IDA, with input from ESA, existing consortiums, IFIs and development agencies. This will ensure that Space for IDA maximises the achievement of its objectives.

We would recommend this evaluation (following ESA and consortium review & approval) becomes public domain. This is best practice in the Development Assistance community as it highlights the results and lessons for all to benefit from. Most importantly it provides potential donor and IFI partners with a robust evaluation of the existing programme to provide clarity on the execution, results and lessons from EO4SD, providing confidence in ESA, and thus increasing likelihood of support to the Space for IDA programme.

TABLE 0: Key learnings from each of the EO4SD projects

EO4SD Project	Learning
Urban Development	Need for greater flexibility in the ESA SoW for product specification
	Differences between the ESA SoW and actual IFI and CS user requirements and timeline
	Need for broader institutional awareness and capacity to fully utilise EO
	Limitation of standardised Work Requirements for different domains
	Need for cost-benefit (CBA) or cost-effectiveness analysis (CEA)
	Improved impact evaluations to assess long term development impacts
	Procurement mechanisms of IFIs
	Limited IFI and CS awareness of the cost/price of EO products
Agriculture and Rural Development	Seniority of IFI team engagement
	Overlaps in scope between EO4SD projects
	Differences between the ESA SoW and actual IFI and CS user requirements and timeline
	Need for increased alignment of resources/match funding from IFIs and CSs
	Need for expectation setting of costs/rates for demonstration versus commercial projects
	Maximise impact by ESA investing in public domain EO products for specific domains
Water Resource Management	Difficulty aligning to IFI programme timelines
	Risk of 'user fatigue' due to overlapping demands across EO4SD projects
	Risk of 'user fatigue' due to non-ESA programmes
	Need for greater flexibility in the ESA SoW regarding the deliverables
	Increase efficiency by streamlining documentation and reporting requirements
	Focusing efforts in fewer countries to provide exemplar 'lighthouse' country demonstrations in each region
	Need for multiple mechanisms for users to access EO products
	Need for ground truthing resources to calibrate EO products
	Focus ESA support on 'EO Regional Expert Centres' in CS
	Clarity on IFI procurement restrictions
	Free EO products for the IFIs versus licensing fees

Background

Background

The European Space Agency (ESA), is an intergovernmental organisation of 22-member states with a mission 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'.[3]

ESA EO4SD

> *'Earth observation is the gathering of information about the physical, chemical, and biological systems of the planet via remote-sensing technologies…EO is used to monitor and assess the status of and changes in natural and built environments.'*[4]

Within the Directorate of Earth Observation Programmes (EOP), since around 2010 ESA has sought to demonstrate the benefits (both quantitative & qualitative) that satellite environmental information (otherwise referred to as Earth Observation; EO) can deliver for the *specific case* of Development Assistance projects and operations. Many of these projects are large infrastructure investments, financed through loans that come with several reporting obligations of their impact (environmental, social, financial).

The main purpose of the initial phase of the EO4SD programme was to raise awareness of the unique capabilities of satellite environmental information to support decision-making and interventions relating to sustainable development. These initial demonstration projects have raised interest within the International Finance Institutes (IFIs) to explore a longer-term, more strategic approach to the integration of satellite environmental information in their activities. It has also led to an initial level of procurement of satellite environmental information by the World Bank Group (WBG), Asian Development Bank (ADB), Inter-American Development Bank (IADB), International Fund for Agricultural Development (IFAD) and the Global Environment Facility (GEF) using their own financial resources.

In 2016, ESA kicked off the current phase of EO4SD running from 2016-2023 with a €25 million budget. The overall objective is to start the integration of satellite information products & services, as 'best-practice' environmental information, in the planning and implementation of the development projects, programmes and activities of the IFIs, together with their respective CS. It will implement Regional Demonstration projects in nine thematic development domains identified in the Memorandum of Intent (MOI) with the World Bank & Asian Development Bank; they are being driven by the requirements of World Bank flagship programmes and projects in the following domains:

- 2016–19: *Agriculture and Rural Development, Urban Development, Water Resources Management,*
- 2018–20: *Disaster Risk Reduction, Fragile & Conflict States, Climate Resilience & Proofing, Marine Resources & Coastal Environment,*
- 2020–23: *Forest Management, Ecosystems Services.*

ESA is planning a future phase of the programme from 2020–2025 called Space for International Development Assistance (Space for IDA). Further information is available in a report authored by Caribou Space and ESA called 'Satellite Environmental Information and Development Assistance: An Analysis of Longer Term Prospects'.[5]

3 ESA. 'Welcome to ESA'. https://www.esa.int/About_Us/Welcome_to_ESA. Accessed November 2018.

4 Wikipedia. 'Earth Observation'. https://en.wikipedia.org/wiki/Earth_observation. Accessed July 2018.

5 Caribou Space and ESA. 'Satellite environmental information and Development Aid : An Analysis of Longer-Term Prospects'. https://eo4society.esa.int/event/european-consultation-meeting-on-expanding-the-use-of-satellite-based-information-in-development-aid-activities/. Accessed November 2018.

Overview of EO4SD projects

The EO4SD programme is comprised of nine 'projects' across specific thematic domains as listed above which are implemented in staggered groups of three from 2016–2023. Each project has one or more IFIs to deliver a portfolio of state-of-the-art EO-based information services that address issues within that thematic domain.

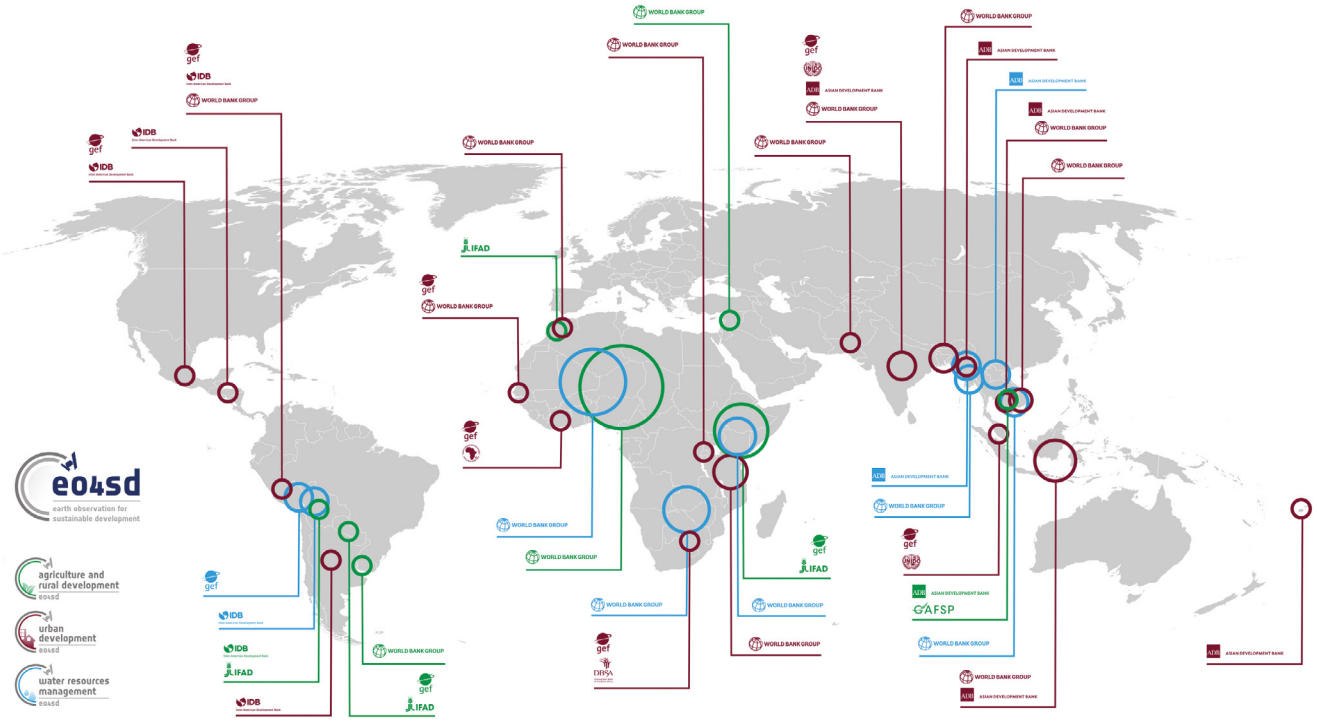

FIGURE 1: Geographic distributions for the areas of interest addressed in the on-going ESA activities in Urban Development, Agriculture & Rural Development and Water Resources Management

Rapid assessment background & objectives

Monitoring and evaluation (M&E) is an objective process of understanding how a project was implemented, what effects it had, for whom, how and why. In programmes with a development objective and/or funded by development finance including Official Development Assistance, rigorous M&E is a common requirement to measure and communicate the development impact of the programme. In these scenarios best practice is to execute an M&E framework throughout the programme from beginning to end. Such frameworks would typically include an M&E Plan,[6] Theory of Change, Results Framework,[7] Baseline Evaluation,[8] Midline Evaluation[9] and an Endline Evaluation.[10]

Because the current EO4SD is funded by ESA Member State subscriptions, not development finance, it has not needed to establish such a rigorous M&E framework. However, the programme does have development objectives and therefore evaluations are beneficial.

As such, Caribou Space were commissioned to conduct an evaluation of EO4SD using a Rapid Assessment approach. This is 'an approach that draws on multiple evaluation methods and techniques to quickly, yet systematically, collect data when time in the field is limited'.[11] It will focus on the thematic domains of Urban Development, Agriculture & Rural Development, Water Resources Management as the first and most advanced EO4SD projects.

6 Details how the programme would execute its M&E framework including definition of audiences, evaluation questions, methodologies and data collection requirements.

7 Often structured as a logical framework (logframe) and would include KPIs, SMART targets, results indicators and indicator sources.

8 Would be completed at the start of the programme to determine starting (baseline) conditions before the programme starts having an impact. It provides the initial values for the indicators in the results framework, from which progress can be measured.

9 Formally assesses interim progress against the programme's primary and secondary aims, allowing course corrections to be made. The Midline Evaluation (and Endline Evaluation) would align to the OECD DAC Evaluation Criteria (Relevance, Effectiveness, Efficiency, Impact, Sustainability).

10 At the end of the programme to assess the final achievement of the primary and secondary aims against baseline conditions, to assess progress and to capture key learnings and recommendations for ESA, the partners and wider space and development sectors.

11 USAID. 'USING RAPID APPRAISAL METHODS'. https://s3.amazonaws.com/gpei-tk/reference_links/en/2010_USAID_-_Using_rapid_appraisal_methods.pdf?1505707314. Accessed November 2018.

This Rapid Assessment will allow EO4SD to be evaluated against the OECD DAC Criteria for Evaluating Development Assistance – which include Relevance, Effectiveness, Efficiency, Impact, Sustainability.[12] It will highlight the development outcomes & impacts of the projects. It will provide recommendations for course corrections for EO4SD. It will draw learnings and recommendations to improve the approach for the next phase which will run from 2020 to 2025, named Space for International Development Assistance (Space for IDA).

The primary audience is the ESA EO4SD team and the project consortiums. The secondary audience is the partner IFIs and CS, and also the wider space and Development Assistance community.

12 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed November 2018.

Urban Development

Urban Development

The Urban Development project aims at demonstrating the benefits of EO-based geo-information products and services (termed EO products herein) to support urban planning tasks in the context of programmes related to the IFIs and stakeholders in CS.[13] It will support initiatives of WBG, ADB, IABD and GEF. It focuses on 32 cities with an emphasis on low-capacity environments (low- and lower-middle-income developing countries), selected megacities and their hinterlands, and secondary (emerging) cities – see Annex A for detail.

The specific objectives of the project are to:

- provide convincing demonstrations of the benefit and utility of EO products in the urban framework,
- provide the intended services on a regional basis for over 30 cities,
- ensure that the EO products are user-driven via a strong engagement with IFI and CS stakeholders,
- provide an operational urban service portfolio offering quality-controlled EO products,
- provide a technology transfer via capacity building exercises in the selected study regions,
- ensure a robust organisation of service networks with the regional counterparts via dedicated local offices,
- develop new business opportunities in urban EO products for the European industry.

13 ESA. 'urban development'. http://eo4sd.esa.int/urban. Accessed December 2018.

Urban Development
Relevance

OECD DAC state 'Relevance' is focused on the extent to which the aid activity is suited to the priorities and policies of the target group, recipient and donor.[14]

To what extent are the objectives of the project still valid?

Globally, 55% of the population lives in urban areas today and this trend is expected to continue – by 2045, the number of people living in cities will increase by 1.5 times to six billion, adding two billion more urban residents. By 2050, 68% of the world's population will be urban and 80% of global GDP generated in cities.[15] However, the speed and scale of urbanisation brings challenges across affordable housing, spread of informal settlements, congested transportation, carbon emissions, and exposure to disaster risk and sea level rise.

Building cities that "work" – inclusive, safe, resilient, and sustainable – requires intensive policy coordination and investment choices,[16] supported by consistent, accurate and up-to-date information on the status and development of the built environment. Earth observation (EO), offers great capabilities for the monitoring, inventory and analyses of urban areas.

The Urban Development project's objectives are aligned to both global, national and city level urban policy frameworks. At the global level United Nations Sustainable Development Goal 11 is to "Make cities and human settlements inclusive, safe, resilient and sustainable" and the project's products allow a full or partial assessment of the SDG Goal 11 Indicators.[17]

Another global policy framework that the project aligns to is the UN 'New Urban Agenda" ratified at Habitat III, the United Nations Conference on Housing and Sustainable Urban Development that took place in Quito (2016), which serve as a guideline for urban development for the next twenty years.[18] Article 156 of the New Urban Agenda states specifically *"The use of digital platforms and tools, including geospatial information systems, will be encouraged to improve long-term integrated urban and territorial planning and design, land administration and management, and access to urban and metropolitan services."* Thus, the EO4SD Urban Development project has a direct bearing on the support to the New Urban Agenda.

At the national level each country has National Urban Policies (NUPs) which provide an overarching coordinating framework to deal with the most pressing issues related to rapid urban development.[19] The NUP process is comprised of several stages through Feasibility, Diagnostics, Formulation, Implementation and Monitoring & Evaluation. In order to implement these steps, there are important aspects to consider, such as urban planning and design and evidence-based approaches for decision making. Urban planning based on quantitative data is increasingly important in developing countries, where urban population pressures result in urban sprawl and development of informal settlements which lack basic services for the residents. The project supports the NUPs especially with the quantitative data for the diagnostics.

Finally, the City Level Policies adapt the NUPs for the local city specific context, and these are supported by the project's geo-spatial products which can be used for preparing, for example, Master Plans, planning/ zoning and monitoring urban growth.

14 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed December 2018.

15 World Bank. 'Urban Development'. http://www.worldbank.org/en/topic/urbandevelopment/overview. Accessed February 2019.

16 Ibid.

17 Including Proportion of Urban Population Living in Slums and Informal Settlements, Ratio of Land Consumption Rate to Population Growth, Proportion of Population that have convenient access to Public Transport.

18 The United Nations Conference on Housing and Sustainable Urban Development. 'THE NEW URBAN AGENDA'. http://habitat3.org/the-new-urban-agenda. Accessed November 2018.

19 UN HABITAT. 'National Urban Policies'. https://unhabitat.org/urban-initiatives/initiatives-programmes/national-urban-policies/. Accessed November 2018.

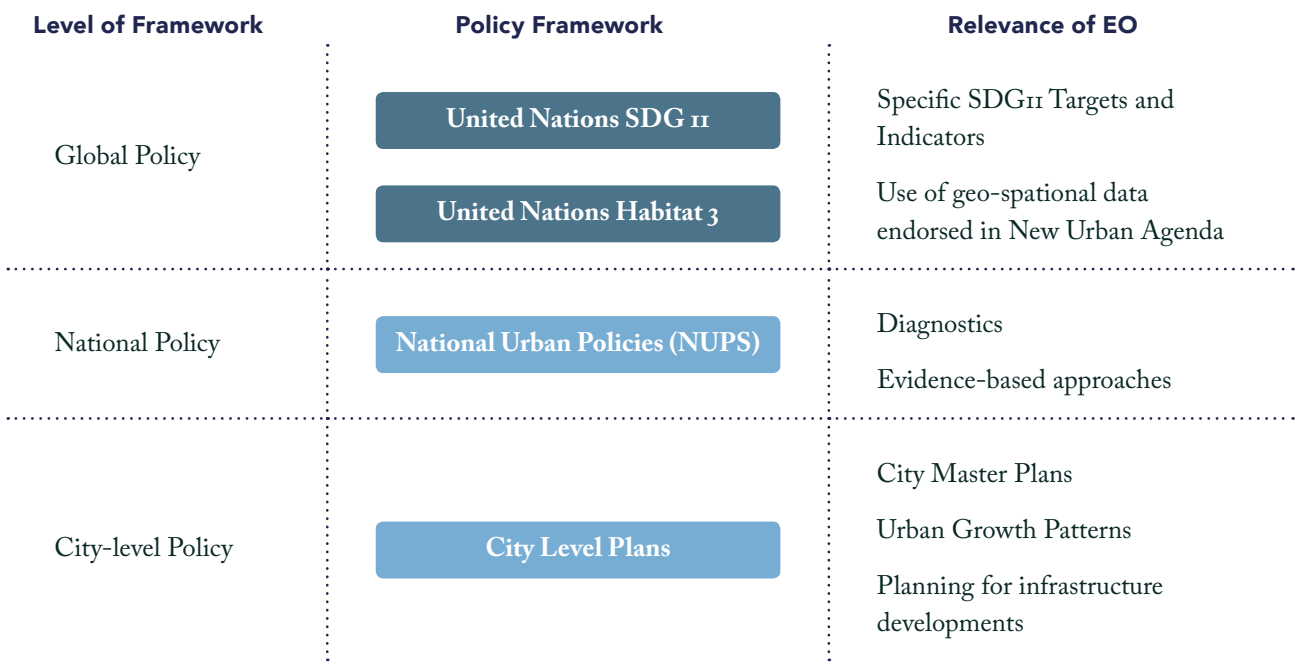

FIGURE 2: Relevance of EO to global, national and city level urban policy frameworks

Are the activities and outputs of the project consistent with the overall goal and the attainment of its objectives?

— *Relevance of project outputs*

The Urban Development project has three deliverables (D1, D2 and D3) that ensure the activities and outputs were relevant to the objectives through extensive engagement with IFIs and CSs.

The Strategic Plan (D1) provided the framework for guiding all activities including, the agreed priorities among the partners in the IFIs and CSs, the EO products to be provided, the IFI programmes and projects to be addressed and the on-going complementary activities with which to cooperate.

The Client State & Stakeholder Capabilities Assessment (D2) conducted an assessment of the stakeholders within CS from the selected IFI programmes/cities with respect to their engagement in using EO technology previously. It assesses institutional, policy, infrastructural and technical issues, gaps and capacity building requirements. In particular it built upon the Strategic Plan (D1) in three major aspects by:

- finalising the list of in-scope cities,
- developing the EO4SD Urban product portfolio brochure,[20] which was not a contracted deliverable, but was seen by the consortium as critical tool for discussing the products with the IFI and CS customers in a non-technical language they understand,
- identifying the IFIs main programmatic needs as: mapping of informal settlements, reporting urban sustainability indicators, and transit-oriented development.

The Service Cluster Portfolio Specifications (D3) defines the EO product specifications, including their utility for a sustainable urban development and required processing steps to generate output products. This information was captured in the publically available EO4SD Urban Development product portfolio brochure.[21] It detailed the products' content and use, resolution, availability and frequency, reliability and benefits and it aided the consortium to summarise the products and engage with stakeholders. The portfolio details 15 products divided into nine primary products and six secondary products with an 80/20 rule, so that the project focuses ~80% of total area coverage and human effort on the primary products.

This portfolio addresses priority requirements for urbanisation programmes for the following use cases: land use allocation and valuation, regulation and zoning, minimising the exposure to natural hazards and public health hazards, and an inventory for city's transport connections, inventory of available labour, goods and services, an inventory of green/recreational areas, and an inventory of socioeconomically problematic areas.

20 GAF AG. 'Urban Development – Service Portfolio'. http://www.eo4sd-urban.info/. Accessed November 2018.

21 Ibid.

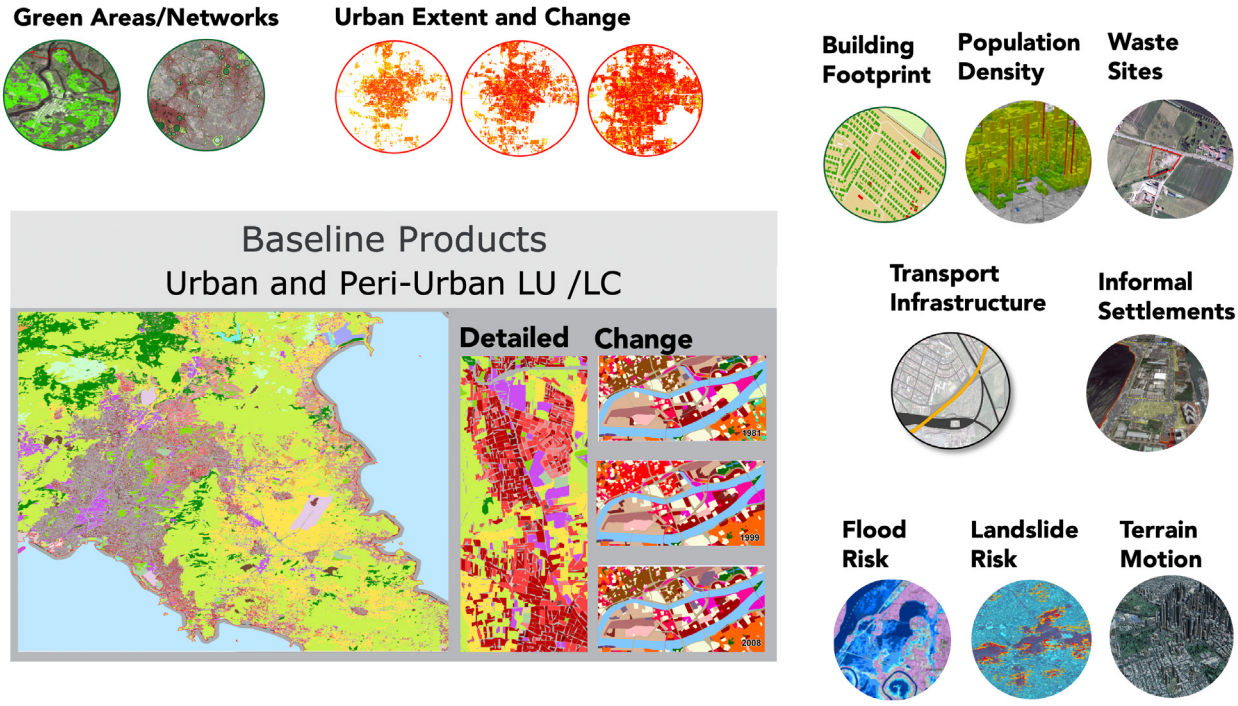

FIGURE 3: Urban Development project's EO products

— *Need for greater flexibility in the ESA SoW for product specification*

The consortium believe that the required product portfolio specified in the SoW was relevant to the overall goal and the attainment of its objectives, following initial discussions of user requirements with IFIs and CS. However, due to the fact that there is an overall experience from the EO industry with products and service provision in the urban domain, the consortium might have been able to define a more relevant, effective and cost-efficient product portfolio with increased flexibility in the SoW on product specifications.

— *Relevance of project geographies*

The project's SoW provided a list of ~150 potential cities in ~40 countries, categorised by income level, population and current IFI programmes. These were selected through consultative meetings between ESA and the IFIs. The consortium then refined the list based on multiple criteria,[22] ensuring the list matched IFI requirements, the available budget, and the consortium's contractual obligations to ESA. The final 32 cities in 12 countries are shown in Figure 4.

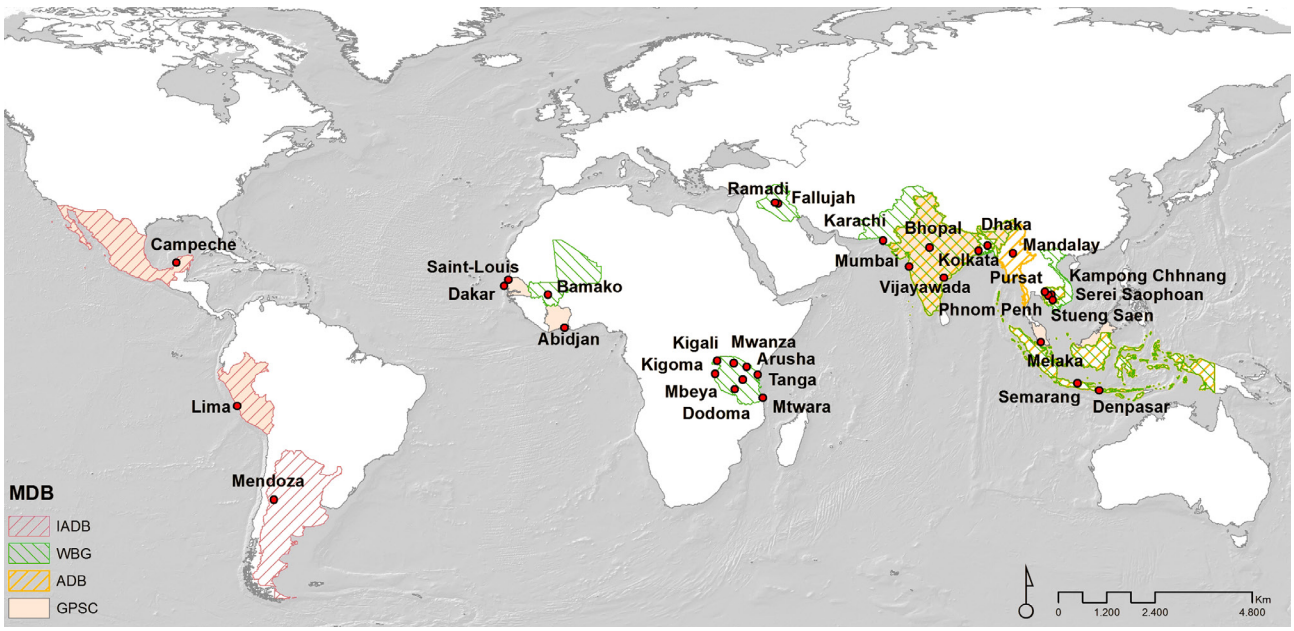

FIGURE 4: Selected cities in Latin America, Africa & Asia

22 Level of engagement of the stakeholder, Clear and confirmed product list, Mostly baseline & derived products required, Clear and confirmed Areas of Interests (AoIs), Information on time-frame for delivery, Status of Programme in Bank Project Cycle/or Importance of Programme

This list of cities is relevant to the programme objectives as it provided a globally representative set of cities in terms of size, location, challenges, level of development, etc. This allowed the consortium to demonstrate an EO product portfolio that is replicable in the future to solve challenges across a wide range of developing world cities.

— *Relevance of project partners*

The selection of project partners is consistent with the overall goal and the attainment of its objectives. Engagement of IFI and CS stakeholders is critical in order to increase the uptake of EO products and mainstream these services within IFI funded activities.

The IFIs were selected based on both the existing relationship and the MOIs with ESA and their existing urban programmes. A comprehensive Strategic Plan (D1) reviewed the main IFI and non-IFI agencies involved in the urban development domain, identified their National Urban Policies, presented examples of their programmes, defined the planned co-operation and identified individual stakeholders. The specific urban programmes within the IFIs, e.g. World Bank's Urban Planning Study for Tanzania, are listed in Annex A.

The project has also engaged with the IFIs global initiatives including Global Platform for Sustainable Cities (GPSC),[23] which is an umbrella programme across 28 cities in 11 countries, that acts as amplifier for the results and lessons of the Urban Development project.

Within the CS the project engages with national stakeholders such as the local governments and other forms of city public administration, ministries who can affect the investment in question and its implementation, local research institutions and technical centres, etc.

Outside of the individual CS the consortium also engaged with global organisations that are relevant to urban challenges. This includes United Nations bodies, e.g. UN Habitat, foundations and NGOs such as Rockefeller Foundation's 100 Resilient Cities programme, and city associations such as Cities Alliance and ICLEI. These associations support cities to implement urban development policies and therefore the engagement of the project provides an additional route to replication and duplication beyond the project.

BOX 1: Relevance lessons for EO4SD (current) and Space for IDA (future) programmes

Need for greater flexibility in the ESA SoW for product specification

a) **EO4SD:** For remaining un-contracted projects (i.e. Forest Management, Ecosystems Services), allow increased flexibility in the SoW Annex regarding Product Portfolio and product specifications (i.e. 'EO-Based Information Services to be Provided'), to allow for the consortiums to propose the most relevant, effective and cost-efficient product portfolio.

b) **Space for IDA:** For procurement SoWs for 'Activity 1: Knowledge Development', allow increased flexibility in the SoW Annex regarding the overall Product/Service Portfolio and product specifications.

23 Supported by Global Environment Facility (GEF) GPSC brings together all participating cities and a wide range of entities that are working on urban sustainability issues to create a shared platform for global knowledge and an evidence-based, integrated approach to realise very worthwhile outcomes.

Urban Development
Effectiveness

OECD DAC state 'Effectiveness' is a measure of the extent to which an aid activity attains its objectives.[24]

To what extent were the objectives achieved / are likely to be achieved?

— *Achievement of work requirements*

There are 21 Work Requirements (WRs) in the ESA SoW, which specify the contractual requirements the consortium has to deliver. These were formally assessed by the consortium in the Annual Report (July 2017, to be updated March 2019) and noted that the majority of the WRs were completed and achieved. The only WRs that were not achieved were:

- **The Regional Workshops** – The IFI programmes are city based, and not regional in nature, and IFI teams did not see the value in regional workshops, so this WR was de-scoped with agreement from ESA.
- **Establishing A Local Office** – Again, as the IFI programmes are city based, a single local office would have only served one city out of 32 and therefore would have been ineffective, so this WR was de-scoped.
- **Alignment of IFI Resources** – Lack of understanding by the IFIs on the need to align resources and provide additional funds for EO products that were beyond the scope of the ESA project. It would be important for the IFIs to understand the nature of the programme right from inception in terms of the collaborative nature and expectation of alignment of resources.

— *Addition of new objective (scope adjustment)*

Following discussions with IFIs and CSs, it became clear that in addition to the EO products, the users required analytical methods to convert the EO data into spatial metrics and statistics that would be meaningful for their urban planning. For example, the application of the Land Use/Land Cover products for assessment of location and types of informal settlement development which could then be used to provide improved services (water/sanitation) to these locations. A Contract Revision to include a Data Analytics work package corrected this.

See the Impact and Sustainability sections for a detailed assessment of the outcomes of the project.

What were the major factors influencing the achievement or non-achievement of the objectives?

— *Positive factors*

Consortium team: The consortium performing the project is composed of eight companies/institutions[25] – lead by GAF AG (Germany) – with deep and complementary EO technical proficiency and wide experience in developing geo-spatial services in the urban domain. Roles and responsibilities within the consortium, IFIs and CS were clearly defined in a Service Cluster Test Report (D7).

Strength of IFI engagement: The IFIs provide centralisation from which the consortium, with their limited resources and manpower, can engage effectively with the 32 cities across the CS. The IFIs provide credibility to the consortium in their engagement with CS stakeholders. The IFIs provide a route to replication of the urban products across other developing world cities in the future. IFIs are highly influential in defining the priorities of the national

24 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed December 2018.

25 SIRS (France), gisat (Czech Republic), egis (France), the German Aerospace Center – DLR (Germany), NEO (The Netherlands), JOANNEUM RESEARCH (Austria), GISBOX (Romania).

development policies through for example the World Bank's Country Partnership Framework, which in turn is informed by a SCD Systematic Country Diagnostic.[26] Finally, the IFIs can also be a direct customer of the urban products in the future.

Initial awareness of benefits of EO: The World Bank and ADB have an early stage awareness of the use of EO data within their urban programmes with a strong emphasis on the engagement with US based academia and EO organisations and capabilities.

Strength of CS engagement: The project has extensive engagement with CS government agencies: including in Tanzania the Ministry of Lands, Housing and Human Settlements Development (MoL); in Indonesia the Badan Perencanaan Pembangunan Daerah (BAPPEDA) and the Agency for Regional Development Planning; and in India the Kolkata Municipal Corporation (KMC) which is under the Ministry of Urban Development (MoUD).

As the end user, and direct beneficiary, the positive CS engagement with the project is critical to the specificity of user requirements, validation and acceptance of the EO products and their long-term adoption.

— *Negative factors*

Differences between the ESA SoW and actual IFI and CS user requirements and timeline: The consortium's contract is with ESA as the primary client/customer. However, the users of the consortium products are the IFIs and CSs. This causes challenges in terms of prioritisation of project scope, product portfolio, timelines and budget. Lack of visibility in the IFIs to the ESA/consortium contract causes an expectations management issue as the IFIs don't have full visibility to limitation on budget and timelines of the consortium. Additionally, the IFI users often have changing priorities for the EO products/time frames – because they use the products in on-going loan/feasibility study programmes and with different consultants.

Embedding of EO into IFIs strategic planning to ensure senior buy-in and budget allocations: Engagement is primarily with IFI Project Officers (POs) and TTLs based on personal contacts, instead of via intuitional formalisation, who further rely on external consultants. The IFI POs and TTLs are under pressure to fulfil their programme objectives and have only short-term interest in using the urban products for their specific project. IFIs have emerging awareness and capacity to utilise EO but this is primarily on a project-by-project basis. To fully utilise EO to address urban challenges and budget and to integrate the technology into work practices in an operational and sustainable manner, will require broader institutional awareness and capacity.

Limitation of standardised Work Requirements for different domains: The SoW is standardised in terms of WRs for each domain, which brings benefits of simplicity, consistency and management efficiency for ESA. However, some WRs might be appropriate for the Water Management project (naturally pan-national), but not for Urban Development (naturally city based), given the vastly different geographic scales.

26 The World Bank. 'Country Engagement'. http://www.worldbank.org/en/projects-operations/country-strategies#3. Accessed November 2018.

Differences between the ESA SoW and actual IFI and CS user requirements and timeline

a) **EO4SD:**

I For the remaining un-contracted projects (i.e. Forest Management, Ecosystems Services) ensure consortium primes are allowed to drive the process with the IFIs, and the related user requirements definition process.

II Summarise and communicate the contractual framework between ESA and consortium to the IFI, and communicate any changes made during the project. This would clarify that ESA is the primary customer/client and manage the IFI and CS expectations.

b) **Space for IDA:** Implement a more robust/detailed cooperation agreement (or similar) between ESA and IFIs to increase clarity of scope, timelines, mutual resource/budgets commitments, particularly for Space for IDA Option 2: New Trust Fund and Joint Work Programme.

Embedding of EO into IFIs strategic planning to ensure senior buy-in and budget allocations

a) **EO4SD:** More senior level engagement from the IFIs to institutionalise EO in the processes of the IFIs strategic efforts/programmes and not only at individual project level. A regular reporting/updating mechanism from EO4SD, including the consortium primes, to the ESA and IFI senior management, for example roundtable briefings, could be valuable.

b) **Space for IDA:** Space for IDA Option 2: New Trust Fund and Joint Work Programme will require senior IFI management agreement (including Global Practice Managers) and they can be regularly updated through a quarterly (or other) reporting cycle from ESA.

Limitation of standardised Work Requirements for different domains

a) **EO4SD:** For the remaining un-contracted projects (i.e. Forest Management, Ecosystems Services) identify unique factors within those domains that would lead to a customised SoW with potentially some unique Work Requirements.

b) **Space for IDA:** Incorporate variability in the SoW Work Requirements across the various domains to allow for unique factors in that domain. Allow consortiums to provide feedback on 'draft' SoW's before opening the official procurement.

Urban Development
Efficiency

OECD DAC state 'Efficiency' measures the outputs – qualitative and quantitative – in relation to the inputs. It is an economic term which signifies that the aid uses the least costly resources possible in order to achieve the desired results.[27]

Was the project implemented in the most efficient way compared to alternatives?

There is no formal value for money analysis, such as cost-effectiveness or cost-benefit analysis, in the programme. However, multiple mechanisms were used to minimise costs and ensure value for money, including:

- The consortium provided mapping of the entire city area using free, low resolution Landsat and Sentinel data, and only used commercial high-resolution data for the urban centre/core where the user's priority was highest,
- Reuse of land-use classification nomenclature from Copernicus Urban Atlas which provides pan-European comparable urban land use data; i.e. a harmonised approach to defining a Land Use nomenclature and product provision,
- GAF as prime have strong existing relationships with the commercial EO data providers, e.g. Airbus, and as a leading reseller, can procure their EO data on very competitive pricing terms. Therefore, they centralised the data procurement budget from across the consortium to save costs,
- At the end of year one, a production cost evaluation was conducted using feedback from the stakeholders collected in the User Utility Questionnaire to identify and remove costly and redundant design features that are not being used.

It is notable that the Prime (GAF AG) voluntarily invested financially over and above the ESA grant even though there was no match-funding requirement, to cover the costs of year one. This was because they identified the strategic, commercial opportunity that will arise from providing EO products to IFIs and CSs.

Were objectives achieved on time?

Against a 36-month timeline the project has only slipped by 3–4 months on a subset of activities, including the user consultation process (Work Package 11) and the subsequent activities related to the production, as the heavy volume of work for full-city coverage had not been planned for year one (this was related to work package 32). Initial engagement with the IFI and CS stakeholders took longer than expected, and therefore the early activities of confirming user requirements, defining the product portfolio and procuring commercial EO data were delayed.

ESA and the consortium have robust mechanisms of ensuring progress to the project plan is on track. This includes, the SoW definition of WRs linked to a Work Breakdown Structure (WBS) and related Work Packages (WPs) with a required timeline and specific deliverables. The consortium then tracks progress on the implementation of the WPs to this timeline and reports to ESA through Quarterly Progress Meetings (as well as Monthly Progress Reports). ESA can mitigate the risk of late or under-performance by controlling the contracted milestone payments, and GAF, flows down contractual requirements to sub-contractors.

27 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed December 2018.

BOX 3: Efficiency lessons for EO4SD (current) and Space for IDA (future) programmes

Need for cost-benefit (CBA) or cost-effectiveness analysis (CEA)

a) **EO4SD:** Consider a Contract Change Control to include a cost-benefit analysis or cost-effectiveness analysis. This would provide quantified economic evaluation results to communicate to ODA agencies and IFIs for collaboration/funding Space for IDA.

b) **Space for IDA:** Include cost-benefit analysis or cost-effectiveness analysis in 'Activity 1: Knowledge Development' as a Work Requirement in SoWs.

Urban Development
Impact

OECD DAC state that 'impact' is the positive and negative changes produced by a development intervention, directly or indirectly, intended or unintended.[28]

What has happened as a result of the project? What are the outcomes and impacts?

The project will lead to both short-term and long-term outcomes[29] and ultimately to long term impacts.[30] The short-term outcomes are for the project's direct beneficiaries, the IFI and CS stakeholders in the urban planning and management domain. Influencing these stakeholders is the main focus for the project and these short-term outcomes are well defined and evaluated below.

The long-term outcomes are those for the indirect beneficiaries within the zone of influence of the project, e.g. residents of the cities, which the project does not have direct influence over. These long-term outcomes are less well defined and are not within the project scope to evaluate. However, it is possible to qualitatively state what the long-term outcomes would be, as per Figure 5.

Equally, the long-term impact, stated in the SoW as the Cardinal Requirement (copied below) is not evaluated for the same reason.

> *'integrate Agricultural and Rural Development EO-based products & services as 'best-practice' environmental information in the planning and implementation of the development projects, programmes and activities of the IFIs, together with their respective CSs'*

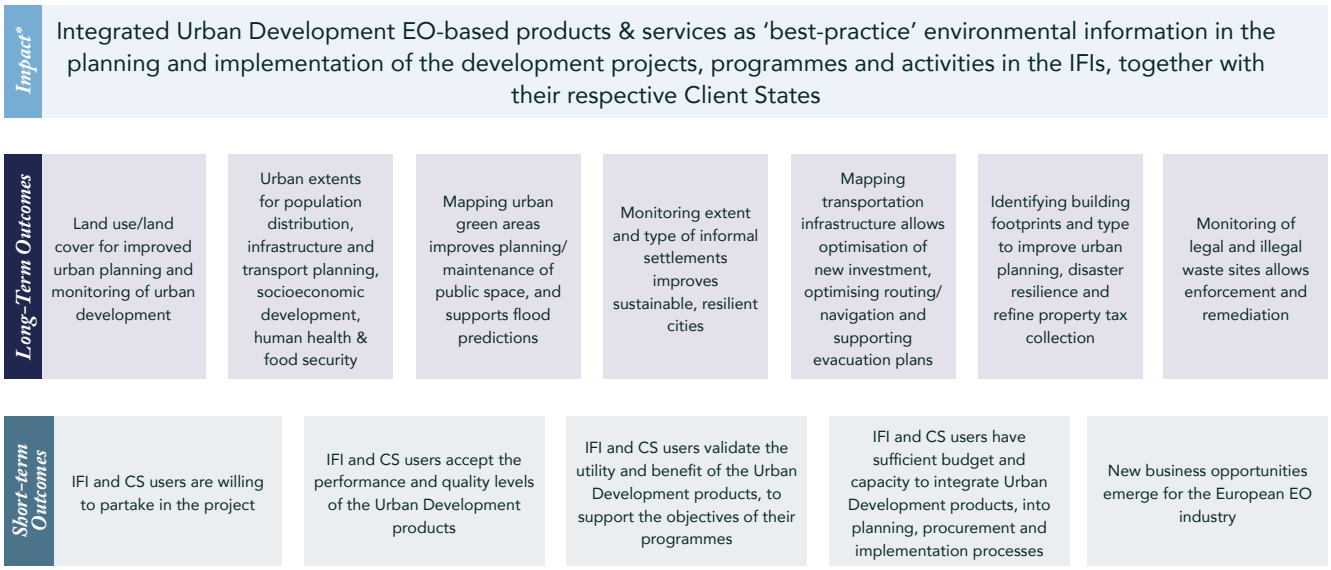

FIGURE 5: Outcomes and impact of the Urban Development project[31] *ITT SoW Cardinal Requirement

28 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed December 2018.

29 The likely or achieved short-term and medium-term effects of an intervention's outputs.

30 Positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended.

31 Caribou Space

— *Evaluation of short-term outcomes*

To achieve the long-term outcomes and the impact, the following short-term outcomes need to occur. These are in the order of the customer journey for IFIs and CSs, in their adoption of EO products:

1. IFI and CS users are willing to partake in the demonstration project,
2. IFI and CS users accept the performance and quality levels of the Urban Development products,[32]
3. IFI and CS users validate the utility and benefit of the Urban Development products, to support the objectives of their programmes,[33]
4. IFI and CS users have sufficient budget and capacity to integrate Urban Development products, into planning, procurement and implementation processes,
5. New business opportunities emerge for the European EO industry.

The short-term outcomes 1, 2 and 3 are assessed below, whilst the sustainability related outcomes 4 and 5 are assessed in the Sustainability section.

— *Short-term outcome 1 IFI and CS users are willing to partake in the demonstration project*

The IFIs and CSs have been very willing to partake in the project. Three IFIs have been engaged across 32 cities in 12 countries across LatAm, Africa and Asia across 14 programmes (see Annex A).

— *Short-term outcome 2 IFI and CS users accept the performance and quality levels of the Urban Development products*

The consortium conducted a Service Demonstration Exercise Specification (D8) at the end of Phase 1. In total, 204 products in total (57 baseline products and 147 other products) of the 12 products in the portfolio and 132 maps were delivered for 16 cities covering a total of 28,868 sq.km for Phase 1. The 'overall accuracy', which means the probability that the observation from the EO product is true when compared to the truth on the ground, was between >85%–95%, with an average over 90%.

Within the Service Demonstration Exercise Specification (D8) a User Utility Assessment (UUA) survey, including a User Utility Questionnaire (UUQ),[34] was completed by users in six IFI Programmes across eleven cities and is being re-run for a further eight-ten cities in 2019. This assessed compliance with user specified standards, performance and quality levels – achieving positive results across these factors. IFI and CS user respondents stated:

> *"The draft version (City Service Operations Report) provides useful information to develop analytics and helps prioritise investment programs on the ground."*

> *"The maps of PP were very helpful in demonstrating urban expansion for the city."*

> *"The project is not yet finished, but we are at an advanced stage of PHASE I and the deliverables so far are satisfactory."*

> *"I find especially valuable the spatial location from high resolution satellite imagery of informal settlements as well as the extent and evolution of waste sites, which are difficult to detect and monitor."*

— *Short-term outcome 3 IFI and CS users validate the utility and benefit of the Urban Development products, to support the objectives of their programmes*

The User Utility Assessment (UUA) survey also assessed the level of impact, utility and benefit realised by the end users. All respondents confirmed the benefit and new insight brought by the EO products. All respondents stated 'high' or 'medium' potential of the EO products to integrate into the country loan/grant programme, stating this would take between six months and three years to achieve. Respondents had the following comments:

> *"Data on land use is scarce in many WBG client countries. Such analysis of existing land use provides useful insights to land use patterns and trends which can inform policy recommendations…"*

> *"We can understand how the city is growing and the implications of that."*

32 Via a formal institutionalised framework between to ESA and the IFI. This is highlighted to clarify that the consortiums contractual relationship is with ESA, instead of the IFIs and Client States.

33 Ibid.

34 Including questions regarding service reliability, service usefulness, service availability, service benefits, service evolution.

> *"Yes absolutely, the EO derived data are a fundamental building block for the analytical model that is at the core of the study. EO data are used as input for a predictive model that estimates measures of the household deprivation in slums."*

> *"We hope to allow the practice to build on this, beyond using the data we collect and our own elaboration, but also incrementing it with future survey-derived data or GIS."*

> *"In addition – pending funds – we wish to create a user-friendly interface. Therefore, we need all the data, and metadata documentation that can allow such goals to be reached."*

The Service Demonstration Exercise Specification (D8) was supplemented with a specific document, called City Operations Report, which detailed methodological aspects, the EO data used, the results of the mapping accuracy assessment figures with the related Quality Control (QC) approach and information, and some basic statistical assessments for each city. This document contains information related to the provision of the EO products and their potential applications; the document is provided to all the cities engaged in the Urban Development project.

The consortium conducted an initial Stakeholder Engagement Review in November 2018, to be updated in November 2019. This assesses the scope, nature and levels of engagement of stakeholders and the effectiveness with respect to achievement of the cardinal requirements to 'integrate EO-based products & services as 'best-practice' environmental information in the planning and implementation of the development projects, programmes and activities of the IFIs, together with their respective CSs.' It showed that IFIs have done extensive in-house and external promotion of the Urban Development project highlighting the sense of ownership by the teams involved in the work done. IFIs state that they are still using the EO products provided and some requested support outside of the project. A vast majority stated they would replicate the exercise for other cities if given the opportunity.

A few users provided feedback that they understood late into the project what the products they would get would look like and how they could be used, so the consortium has learnt to simplify their communications to ensure that the common user can grasp the products and make quicker decisions on their utility.

BOX 4: Impact lessons for EO4SD (current) and Space for IDA (future) programmes

Improved impact evaluations to assess long term development impacts

a) **EO4SD:** Inclusion of a Rapid Assessment for the remaining EO4SD projects.

b) **Space for IDA:** Include for consortiums to conduct an impact evaluation, in 'Activity 1: Knowledge Development' as a Work Requirement in SoWs.

Urban Development
Sustainability

OECD DAC state that 'sustainability' is concerned with measuring whether the benefits of an activity are likely to continue after donor funding has been withdrawn. Projects need to be environmentally as well as financially sustainable.[35]

What activities did the project execute to ensure the benefits of the project continue after donor funding ceased?

The Urban Development project has a strong objective to ensure long term adoption of the products so that the development impacts of the project continue after the funding ends. The main tools for this are the Capacity Building Plan (CBP) (D9), a Communication Plan (CP) (D5) and an EO Service Cluster Mainstreaming Roadmap (D14).

— *Capacity Building Plan*

The CBP provides a technology transfer via capacity building exercises in the selected study regions to:

- ensure a robust organisation of service networks with the regional counterparts via dedicated local offices,
- develop new business opportunities in urban EO services for the European industry.

To define the Training Requirements and Capacity Assessment for the CBP the consortium conducted semi-structured, telephone interviews with the IFIs, to obtain information on the training requirements of the local stakeholders. The training modules are differentiated by experience, including entry level awareness-raising[36] and more expert, technical-training programmes.[37] Feedback from both the trainers and the stakeholders following the training sessions is documented to improve the training sessions.

A combination of classroom training and distance learning is used including:

Distance training via webinars – A series of 11, sixty-minute webinars between June 2018 and February 2019 aimed at reaching the wide and diverse audience. These include an overview session; four sessions on technical basics for GIS and EO, and one on urban use cases from various cities. Each webinar is recorded and made available on the project's website[38] to maximise audience uptake. Live polls during the webinar, and post webinar surveys, gather feedback to improve the future webinars. To date four have been conducted with a total of 27 attendees for the live webinars, and 163 have accessed the recordings.

City specific products training via videoconference – Specific training conducted via videoconference or teleconference for each individual city using a detailed set of presentation material for each individual city. To date, two have been conducted with eight attendees from Indonesia; the participants were all from the City Planning Units in Semarang and Denpasar. The benefits that have been observed are that the City Planning teams had the possibility to interact directly with the consortium to better understand the technical aspects of EO data, its utility and limitations for urban planning.

Selected regional training (physical training) – Physical training focused on the audience and issues for a specific city. However, the consortium has found it a challenge to secure co-financing for costs of the venue and travel from the IFIs. One will be hosted in Mandalay in Myanmar (March 19) co-funded with ADB.

35 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed December 2018.

36 Introduction to Geo-spatial Products, and Application of Products to Urban Planning

37 Introduction to Geo-spatial Products, Management and Pre-processing Steps, Thematic and Product Related Processing Steps, Product Accuracy Assessment.

38 ESA. 'Webinars'. http://www.eo4sd-urban.info/. Accessed January 2019.

— *Communication Plan*

Whilst the CBP is focused on a highly targeted, finite audience, the Communication Plan allows the Urban Development project to raise awareness, share results and learnings to a broader audience, using:

- a general-purpose hard-copy brochure summarising the products,[39]
- flyers, posters, flipcharts and corresponding electronic versions,
- 204 sample map products provided to IFI and CS users,
- 13 conferences/workshops and meetings,
- a project website including news messages and an interactive EO data portal.[40]

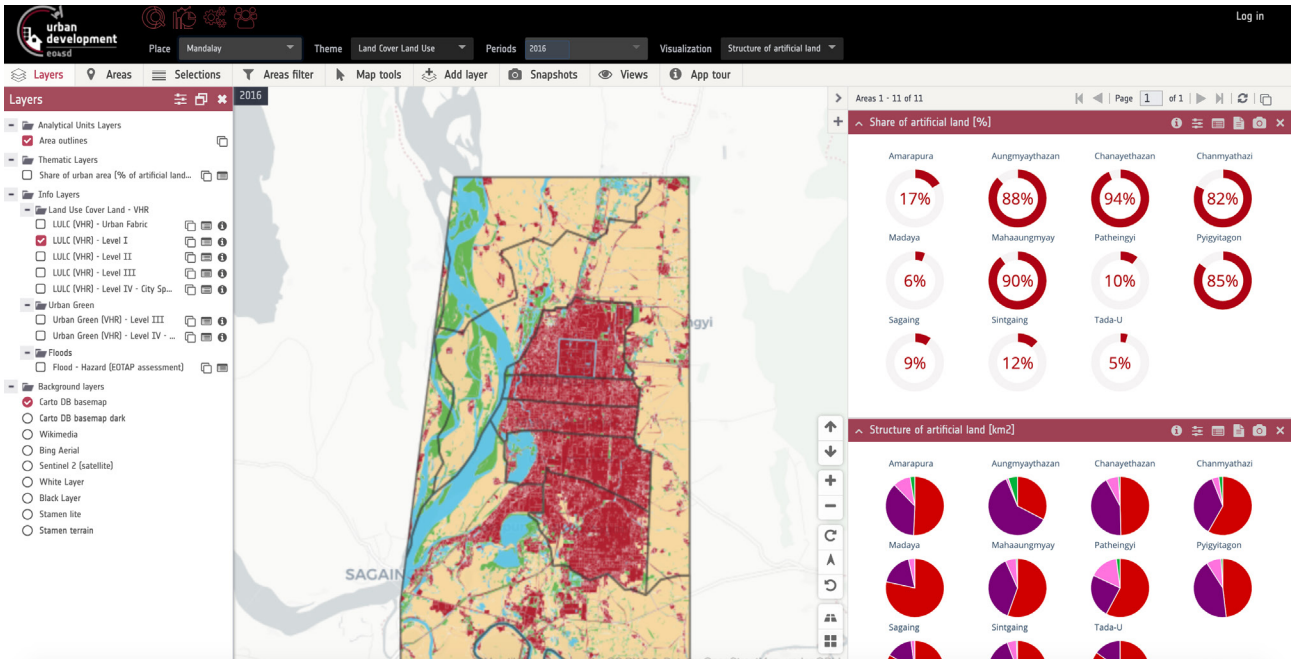

FIGURE 6: Interactive EO data portal on the project website

— *EO Service Cluster Mainstreaming Roadmap*

A road-map for the long-term use of EO products both within the IFI working practices and within the CS, will be completed at the end of the project in February 2020 (month 36).

To what extent did the benefits of a project continue after donor funding ceased?

There are two specific short-term outcomes related to sustainability as assessed below:

— *Short-term outcome 4*
IFI and CS users have sufficient budget and capacity to integrate Urban Development products into planning, procurement and implementation processes

The comprehensive Capacity Building Support Package (D9) detailed above will be completed in November 2019. It has the objective to ensure the IFIs and CS have sufficient capacity to integrate the Urban Development products in the planning and implementation of their development projects, programmes and activities. The initial results as captured in the Capacity Building Activities Review and Stakeholder Engagement Review (November 2018), indicate a high interest in the applications of EO for spatial analytics for urban planning. The webinar series for example, initially attracted a high level of participation but needs further promotion in 2019.

The IFIs and CS have aligned their urban programme team resources to support the Urban Development project. However, this is currently on a short-term basis for objectives of that single urban programme, and there is less evidence of IFI and CS integrating the technology into work practices in an operational and sustainable manner. In terms of aligning budgets, ADB have committed to support the funding of a 2–3 day capacity building event in Myanmar covering logistics and hosting costs. The consortium is aiming for more aligning of budgets in 2019.

39 GAF AG. Urban Development – Service Portfolio. http://docs.wixstatic.com/ugd/3b0000_a7a31c0fa5b74a2d91dec8a74ff2feb2.pdf. Accessed November 2018.

40 ESA. 'urban development EO4SD'. http://www.eo4sd-urban.info/. Accessed November 2018.

— *Short-term outcome 5*
New business opportunities emerge for the European EO industry

GAF and the wider consortium have been able to develop in depth understanding of the role of EO for developing world urban environments, a full suite of products, and extensive working relationships with IFIs and CSs in 32 cities across 11 countries. This global visibility for the consortium to potential customers can be utilised to secure new IFI or CS tenders outside of the ESA scope. An example of which is that ADB prepared a tender for additional mapping work to be done for Kolkata and GISAT in Mandalay as a direct result of the Urban Development project in that city; a consortium partner subsequently won the tender and is currently implementing the work.

What were the major factors which influenced the achievement or non-achievement of sustainability of the project?

— *Positive factors*

Comprehensive capacity building and communication activities: Mandated by ESA through the SoW requirements and then delivered rigorously by the consortium.

The user validation exercise: During year one the consortium provided evidence of the overall impact of the Urban Development products on IFI and CS programmes. This will motivate users in IFIs and CSs to further integrate and mainstream EO products into their urban planning work practices.

Promotion by IFIs to potential users: The positive results in year one has led to a multiplier effect with IFI programmes promoting the Urban Development project to CS users outside of the project scope. WBG highlights the project, and its webinars, on the GPSC website, presenting ESA as 'Partners'.[41] WBG have invited GAF and the consortium to support a new City Resilience Programme. Finally, the consortium has been invited to present at a workshop in Durban to 15 African cities.

— *Limiting factors*

Procurement mechanisms of IFIs: The same lack of broad institutional awareness and capacity within IFI internal teams and external consultants leads to EO not being considered as a required component, and consequently is not included in Project Design Documents (PDD) or tender Terms of Reference (TOR). Additionally, the technical aspects in the PDD are often drafted in unclear technical terms which raises difficulties for consortiums to respond to accurately. Through the tendering process the heavy weighting on expert Curricula Vitae (CV) and final price, versus the technical approach to provide the EO products, can lead to selection of consortiums that do not provide the highest quality and/or most cost-effective products. The evaluation of tenders where there is an EO component is often undertaken by non-technical IFI staff and/or consultants who do not have the required EO background to evaluate the tenders.

Limited awareness of the cost/price of EO products: Users in the IFIs are pleased with the provision of free EO products, but there is low awareness of the costs of EO data and products, and limited operational budget to fully exploit EO. Additionally, EO products are hard to price by industry and provision of estimates is risky for consortiums, due to highly variable, customisable specifications, and lack of industry standards.

41 Global Platform for Sustainable Cities. 'PARTNERSHIPS'. https://www.thegpsc.org/partnerships. Accessed November 2018.

Procurement mechanisms of IFIs

a) **EO4SD:** Document with recommendations on procurement of EO products from EO4SD programme (not a single project consortium) to the IFIs.

b) **Space for IDA:** Include in Space for IDA 'Activity 2: Capacity Building for IFIs' a 'best practice guidelines for IFIs procuring EO' (or similar), with input from IFIs and consortiums.

Limited awareness of the cost/price of EO products

a) **EO4SD:** Encourage EO4SD project consortiums to include some form of pricing estimates for their product portfolios within Portfolio Specifications (D_3).

b) **Space for IDA:** Include in Space for IDA 'Activity 2: Capacity Building for IFIs' a 'pricing guidelines for EO products', to communicate the factors that affect EO product price, and if possible broad price ranges for thematic use cases, e.g. monitoring informal settlements.

Agriculture and Rural Development

Agriculture and Rural Development

The EO4SD Agriculture and Rural Development project aims to demonstrate that the effectiveness of the IFIs technical assistance interventions and financial investments in agriculture sector can be measurably enhanced by using EO-derived information.[42] It focuses on IFI programmes with WBG and International Finance Corporation (IFC), IFAD, IADB and ADB that deal with land degradation, soil erosion, food security and irrigation systems management.[43] It focuses on eight countries across Africa, Latin America and Asia continents (see Annex A for detail).

The use cases supports are:

- large-scale crop area and type estimate (i.e. crop cover mapping and status assessment),
- irrigation and irrigation systems management (i.e. energy balance, water productivity and water stress),
- agriculture productivity assessment (i.e. yield estimation, ground water, precipitation monitoring),
- rural infrastructure investments planning and monitoring (i.e. households and transport networks mapping),
- Land Degradation Assessment (i.e. land use, rainfall, soil moisture, precipitation, fAPAR, NDVI indicators),
- ecosystem services assessment (i.e. water quality assessment, nitrogen content, land surface properties),
- Environmental Impact Assessment (EIA) (i.e. landscape level classification and change mapping including fragmentation, and agriculture commodities production impact on deforestation).

42 ESA. 'agriculture and rural development'. https://www.eo4idi.eu/. Accessed December 2018.

43 Ibid.

Agriculture and Rural Development
Relevance

OECD DAC state 'Relevance' is focused on the extent to which the aid activity is suited to the priorities and policies of the target group, recipient and donor.[44]

To what extent are the objectives of the project still valid?

Agricultural development is one of the most powerful tools to end extreme poverty, boost shared prosperity and feed a projected 9.7 billion people by 2050. Growth in the agriculture sector is two to four times more effective in raising incomes among the poorest compared to other sectors, and 65% of poor working adults made a living through agriculture.[45]

However, the global agriculture sector faces multiple challenges today, many of which are more acute in developing countries. Low agricultural production remains a major issue in developing countries and is a contributing factor to food security risk, with 815 million people still said to be hungry today[46] and micronutrient deficiency affecting an additional two billion.[47] Concurrently, there is growing demand for food and agricultural land due to human population expanding to 10 billion by 2050.[48] Unpredictable and extreme weather patterns, loss of land and changes in growing conditions caused by climate change present significant challenges for the agriculture industry globally. Access to natural resources such as land and water is under pressure; agriculture accounts for 70% of water use, 25% of greenhouse gas emissions,[49] and 80% of deforestation worldwide and generates unsustainable levels of pollution and waste.

Therefore, the central question on the future of global sustainable development is how this vast increase in agriculture commodities supply can be achieved in a sustainable way. EO helps addresses this challenge by improving the accuracy and relevance of decision support tools, improving affordability of credit products, supporting sustainable management of environmental resources and supply chain traceability, aiding resilience to climate change and reducing supply chain losses.[50]

The Agriculture and Rural Development project will support IFI and CS stakeholders to be users and beneficiaries of EO information. The CS stakeholders are public institutions responsible for agriculture, trade, environment, national planning and environmental and natural resources management, as well as research centres and monitoring agencies, private sector investors in agricultural markets and commodities production.

The consortium in the Service Cluster Portfolio Specification (D3) have identified the relevance of EO for stages of an IFIs agricultural project cycle for all of the products. A single example for the agricultural production service product is shown in Figure 7.

44 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed December 2018.

45 World Bank. 'Agriculture and Food Overview'. http://www.worldbank.org/en/topic/agriculture/overview. Accessed November 2018.

46 Food and Agriculture Organisation (FAO). 'The State of Food Security and Nutrition in the World 2017'. http://www.fao.org/state-of-food-security nutrition/en/. Accessed November 2018.

47 Thomson Reuters. 'How Will We Fill 9 Billion Bowls by 2050?'. http://reports.thomsonreuters.com/9billionbowls/. Accessed November 2018.

48 United Nations Department of Economic and Social Affairs. 'World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100'. Posted on 21 June 2017 at https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html. Accessed November 2018.

49 United Nations Department of Economic and Social Affairs. 'World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100'. Posted on 21 June 2017 at https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html. Accessed November 2018.

50 Caribou Space. 'Space for Agriculture in Developing Countries'. https://www.spacefordevelopment.org/library/space-for-agriculture-in-developing-countries/. Accessed November 2018.

Level of Framework	Policy Framework	Relevance of EO
Strategy Definition	Country Partnership Framework	Define agricultural baseline scenario e.g. crop productivity Support country assistance strategies
Project Identification & Preparation	Project Concept Note Project Appraisal Document	Spatial extent and condition of agricultural production
Implementation	Implementation Status and Results Report	Monitoring of programme impacts e.g. improvement to crop productivity
Monitoring & Evaluation	Implementation Completion and Results Report	Assess impact using crop distribution and productivity indicators

FIGURE 7: Relevance of EO for stages of an IFI agricultural project cycle for, as an example, the agricultural production service product

Are the activities and outputs of the project consistent with the overall goal and the attainment of its objectives?

The Agriculture and Rural Development project has many deliverables (D1, D2, D3, D4) that ensure the activities and outputs were relevant to the objectives through extensive engagement with IFIs and CS.

The Strategic Plan (D1) provided the framework for guiding all activities, including the agreed priorities among the partners in the IFIs and CSs, the information services to be provided, the IFI programmes and projects to be addressed and the on-going complementary activities with which to cooperate. This was completed as part of the set-up activities through stakeholder consultations in Rome, Washington and Manila with IFI staff. The analysis was comprehensive and high quality and provided a robust landscape of the IFI and CS programmes and most promising stakeholders and services for the project's objectives.

The Client State & Stakeholder Capabilities Assessment (D2) conducted an assessment of the CS stakeholders from the selected IFI programmes. Stakeholders were classified into groups as per Figure 8, their influence, commitment and their capacity in uptake of EO services was also defined.

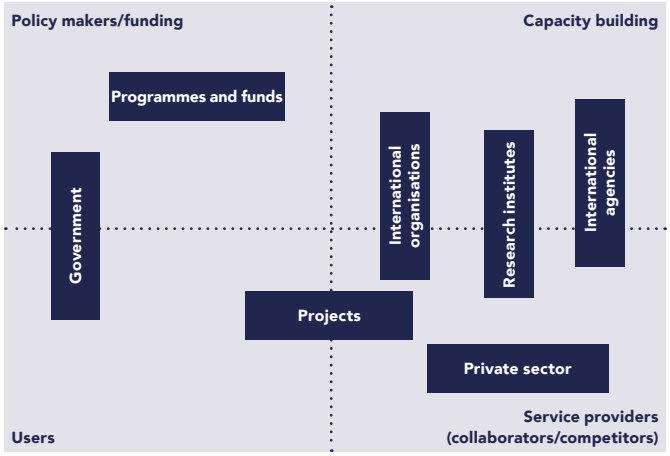

FIGURE 8: Stakeholders categories, roles and positions

The Service Cluster Portfolio Specifications (D3) defined the Products and Service Specifications, including their utility for an agricultural context. A public version,[51] details the products' use, input products, resolution, benefits and delivery format. There are 18 products in total.

The user requirements process to define the Service Cluster Portfolio Specifications had two stages. Initial discussions were held with IFI staff to define seven core Technical Requirements (TRs) for the

51 ESA. Agriculture and Rural Development | Service Portfolio. 'https://www.eo4idi.eu/sites/default/files/eo4sd_agri_portfolio_170529_singlepag.pdf. Accessed November 2018.

project,[52] e.g. 'multi-scale monitoring services to assess agricultural production typically required on the regional, national and provincial scales'. As not all TRs are applicable to all countries a mapping of countries to the required TRs was conducted by the consortium.

Following selection, the consortium at the start of year one consolidated and refined the IFI user requirements via workshops at the IFI headquarters in Rome, Washington and Manila. This process was supplemented with in-country meetings with CS stakeholders in Bolivia, Cambodia, Morocco, Uganda, Ethiopia, Kenya, USA, Italy and Philippines. At the end of year one the IFI & CS requirements were agreed by ESA for implementation in year two and three. The product portfolio addresses use cases for IFI and CS agriculture and rural development programmes, as listed in Box 6. All the products follow a similar delivery chain as shown in Figure 9.

BOX 6: Agriculture and Rural Development product portfolio

Agriculture and Rural Development product portfolio

- Agricultural Production Mapping and Monitoring Service
- Crop Yield Prognosis
- Land Status Indicators
- Land Degradation Assessment
- Land Degradation Monitoring
- Soil Erosion Mapping
- Agricultural Commodity Production Risk Monitoring Service
- Agriculture Ecosystem Mapping and Monitoring
- Rural Infrastructure & Supply Chain Mapping
- Land Suitability Mapping
- Food Security
- Index Insurance Service
- Environmental Impact Assessment and Strategic Environmental Assessment
- Monitoring and Evaluation for Environmental and Social Safeguards
- Irrigation Development Service
- Irrigation System Design
- Irrigation System Operations
- Irrigation Performance Service

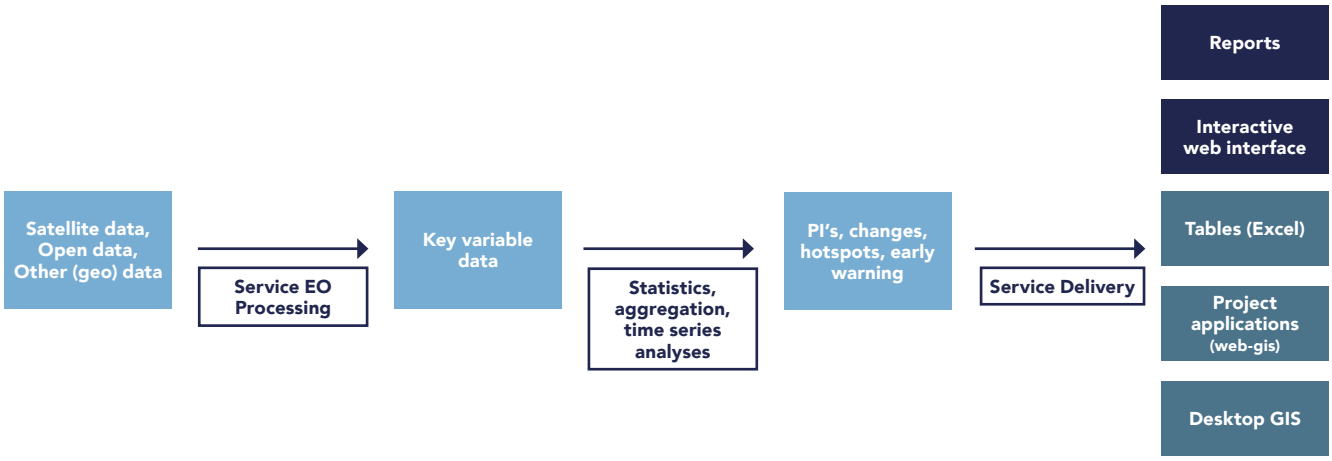

FIGURE 9: General overview of service delivery chain, from satellite data to end-users

52 Multi-scale monitoring services to assess agricultural production, Monitoring and Evaluation (M&E) tools to assess land degradation and environmental conditions, Management of the impact on agriculture commodities production on deforestation and ecosystems health and sustainability, Ecosystem services provided by agriculture, Rural infrastructure investments planning and monitoring, Food security and agricultural risk management, Support to IFIs Environmental and Social Safeguards Framework.

Relevance of project geographies

The consortium refined the list of countries through evaluation of initiatives and the stakeholder consultation feedback, using a series of criteria to ensure they were relevant for the overall goal of the project and achievement of the objectives.[53] The final country selection is: [54]

- **Africa:** Sahel Belt, Burkina Faso, Morocco, Uganda and Ethiopia,
- **Latin America and Caribbean:** Bolivia,
- **Asia:** Cambodia,
- **Middle-east:** Syria.

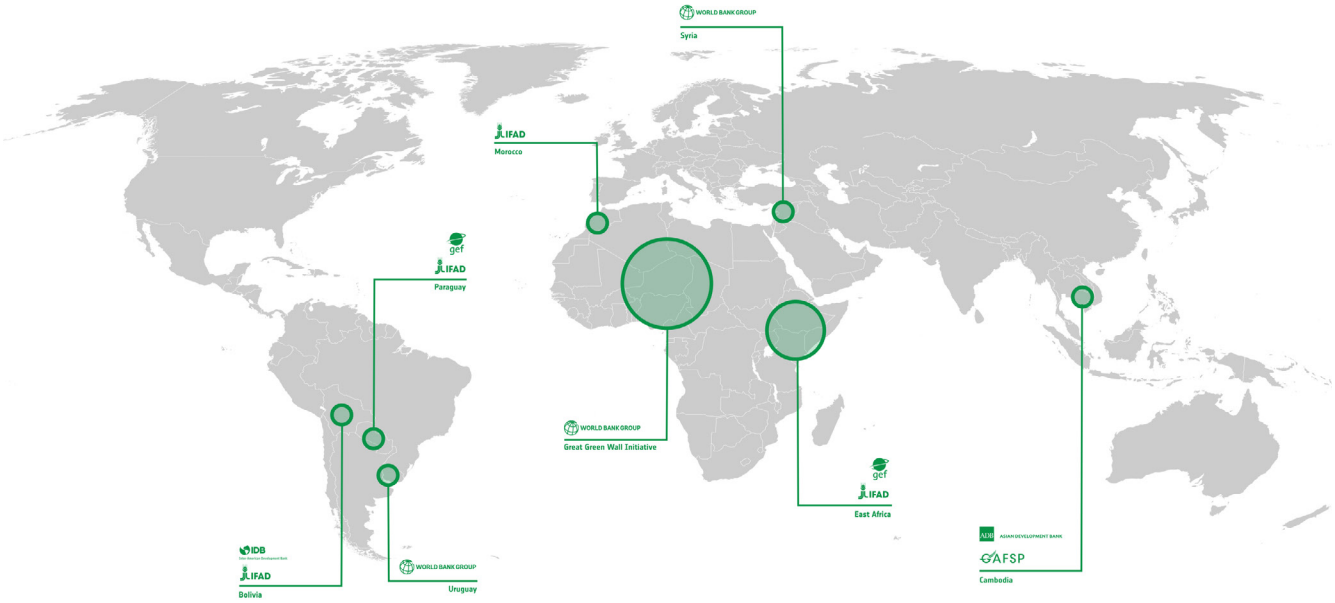

FIGURE 10: Relevance of EO for stages of an IFI agricultural project cycle for, as an example, the agricultural production service product [54]

Relevance of project partners

The selection of project partners is consistent with the overall goal and the attainment of its objectives. Engagement of IFI and CS stakeholders is critical in order to increase the uptake of EO products and mainstream these services within IFI funded activities. The IFIs were selected based on both the existing relationship and MoIs with ESA and their existing agriculture and rural development programmes. The IFIs role is to open a dialogue with the CS for ESA and the consortium, provide the framework through which ESA and the consortium can engage, and to support long term mainstreaming of the EO products. The IFI programmes that EO4SD engages are listed in Annex A.

The CS stakeholders include government agencies, public institutions, research centres, monitoring agencies and private sector investors. These are critical to achieving the project objectives because they are the responsible parties in each country for the agricultural and rural sector. The user requirements are defined by the CS, in particular the 'Champion Users', who were identified as the most engaged organisations in the project.

Outside of the individual CS the consortium also engages with global organisations that are relevant to agriculture and rural development domain. These include the Consultative Group on International Agricultural Research (CGIAR) which is a global research partnership for a food-secure future. The consortium engaged with CGIAR Centers ICRAF (World Agroforestry Centre) and CIAT (International Center for Tropical Agriculture) and other global non-governmental organisations in particular WRI (World Resources Institute), The Nature Conservancy, IUCN (International Union for Conservation of Nature), and CI (Conservation International) (GEF Project Agency). The benefit of this is they act as umbrella organisations that can be amplifiers for the results and lessons of the project to other countries and programmes in the future.

BOX 7: Relevance lessons for EO4SD (current) and Space for IDA (future) programmes

No specific relevance lessons from Agriculture and Rural Development project

53 Adequate representation of the different IFI initiatives, Involvement of the different IFIs, Balance between the themes covered, Timing of project activities, Support and prioritization from the IFIs, Demonstration potential.

54 Uruguay and Paraguay are no longer in scope but part of the capacity building events

Agriculture and Rural Development
Effectiveness

OECD DAC state 'Effectiveness' is a measure of the extent to which an aid activity attains its objectives. [55]

To what extent were the objectives achieved / are likely to be achieved?

— *Achievement of work requirements*

The 21 Work Requirements (WRs) as presented in the ESA SoW specify the contractual requirements the consortium has to deliver. The consortium formally assessed progress to these in the deliverables and noted that all WRs were completed and achieved.

See the Impact and Sustainability sections for a detailed assessment of the outcomes of the project.

What were the major factors influencing the achievement or non-achievement of the objectives?

— *Positive factors*

Consortium team: The consortium is composed of eight companies/institutions.[56] The consortium prime is eLEAF which specialises in satellite-based applications and data to optimise crop production and water management and have delivered such products in more than 50 countries. Roles and responsibilities were clearly defined in the proposal and Service Cluster Test Report (D7), Service Demonstration Exercise Specification (D8) and Stakeholder Engagement and Capacity Building Plan (D4).

Strength of IFI engagement: The IFIs provide centralisation from which the consortium can engage effectively with the eight countries. The IFIs provide credibility to the consortium in their engagement with CS stakeholders. The IFIs and CSs supported consortium events in their countries and at the IFI headquarters with logistical and financial support (e.g. the ADB project financed a capacity building event in Cambodia), co-organised events for the consortium to showcase the services (Info Sessions at the World Bank, IFAD and ADB) and invited the consortium to IFI organised events (such as the Asian Water Forum).

The IFIs provide a route to replication of the products across other developing world countries in the future. IFIs are highly influential in defining the priorities of the national development policies through, for example, the World Bank's Country Partnership Framework, which in turn is informed by a SCD Systematic Country Diagnostic.[57] IFIs can also be a direct customer of the Agriculture and Rural Development products in the future.

Initial awareness of benefits of EO: IFIs have different levels of awareness of the use of EO data and services within their agriculture programmes. One IFI uses a number of services (for example productivity data) for a number of projects but is looking for means to enlarge the services and scale up. A different IFI had some exposure to EO services but is currently restructuring its internal organisation to be able to support such services institute wide – this aided the consortium as they are experienced in the delivery of services to customers at the commercial level and are able to upscale operationally. Another IFI is advanced

55 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed December 2018.

56 eLEAF is supported by a range of specialist service providers in the European EO sector, including DHI Gras (Denmark), GeoVille (Austria), University of Twente – ITC (The Netherlands), Satelligence (The Netherlands), Lahmeyer International (Germany), Nelen & Schuurmans (The Netherlands) and SpaceTec Partners (Belgium).

57 The World Bank. 'Country Engagement'. http://www.worldbank.org/en/projects-operations/country-strategies#3. Accessed November 2018.

in the use of EO and has its own programmes, but still requires access to new services especially in the CS and is looking for ways to scale up.

Strength of CS engagement: The project has extensive engagement with CS government agencies, including the various Ministry of Agriculture. For each IFI programme the consortium identified through the Strategic Plan (D1) the other CS 'Main actors' to engage with. For example, for the Building Resilience through Innovation, Communication and Knowledge Services (BRICKS) project, this was with the Interstate Committee for Drought Control in the Sahel (CILSS) and the Sahara and Sahel Observatory (OSS). Strong CS engagement is critical as they are the end user and direct beneficiary, and are required for specificity of user requirements, validation and acceptance of the products and their long-term adoption.

— *Limiting factors*

Seniority of IFI team engagement: Engagement is primarily with IFI Project Officers (POs) and TTLs based on personal contacts instead of via intuitional formalisation, who further rely on external consultants. The IFI POs and TTLs are under pressure to fulfil their programme objectives and their interest is using the EO products for the limited term of their specific programme.

Overlaps in scope between EO4SD projects: There is potential for overlapping scope between different EO4SD projects. For example, Agriculture and Rural Development has EO products focused on 'Irrigation and irrigation systems management' which is also relevant to the Water Resources Management project. This risk is managed well by eLEAF as they are also in that consortium – and have converted this to an advantage, for example co-hosting InfoSessions. However, the risk for EO4SD programme broadly is as EO4SD implements all the nine domains planned, there may be duplication of effort and also multiple consortiums may approach the same IFI teams with similar requests – creating confusion and appearance of lack of coordination.

Differences between the ESA SoW and actual IFI and CS user requirements and timeline: In the existing EO4SD procurement mechanism (Figure 11 left side) ESA is the direct client for the consortium, however both the IFIs and CS act as other customers and are involved in defining user requirements, priorities and timelines, which sometimes don't align to the Work Requirements (WRs) and timeline in the ESA contract. The IFI programme timelines will rarely align well to the ESA programme timelines. This issue was mitigated by having the first year to compare the IFI and CS requirements against the assumptions in the SOW, adjust them if needed, and to update the service portfolio.

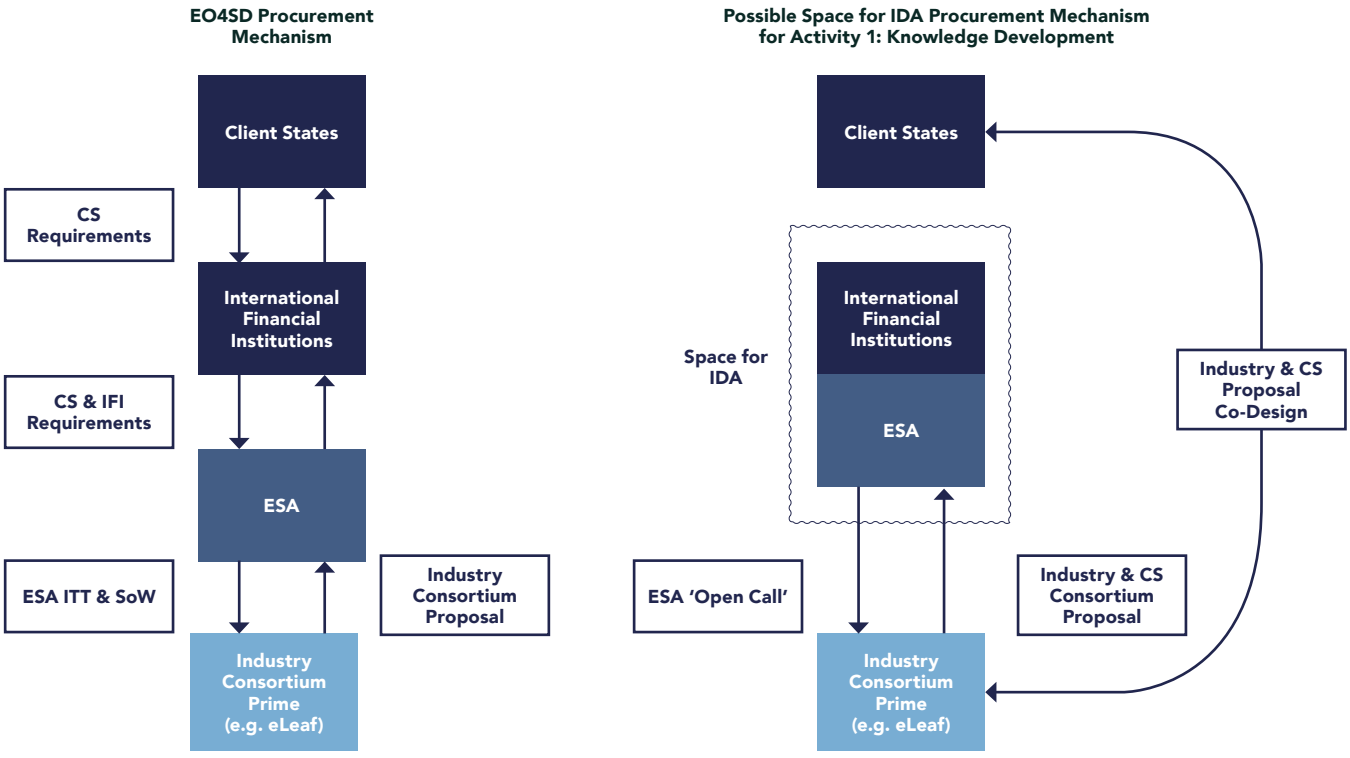

FIGURE 11: Potential difference in procurement mechanisms between EO4SD and Space for IDA Activity 1: Knowledge Development

BOX 8: Effectiveness lessons for EO4SD (current) and Space for IDA (future) programmes

Seniority of IFI team engagement

a) **EO4SD:** More senior level engagement to institutionalise the processes in the IFIs strategic efforts/programmes and not only at individual project level.

b) **Space for IDA:**

I Evolve the 'ESA Secondment' approach to an expanded 'ESA Secretariat' within the IFIs, which would include the role of engaging IFI senior management at HQs.

II Host multi-sector InfoSesssions at IFI headquarters to brief and engage IFI senior engagement.

Overlaps in scope between EO4SD projects

a) **EO4SD:** EO4SD team, particularly the secondees at WB and ADB to identify and mitigate scope overlap across EO4SD and risk of multiple consortium approaches to same IFI teams.

b) **Space for IDA:** Evolve the 'ESA Secondment' approach to an expanded 'ESA Secretariat' within the IFIs that would act as a coordinating team/function between the IFIs and the industry consortiums. This would need careful design to avoid disadvantage of consortium primes being 'one step removed' from IFIs which could cause delays.

Differences between the ESA SoW and actual IFI and CS user requirements and timeline

a) **EO4SD:** None

b) **Future – Space for IDA:** For 'Activity 1: Knowledge Development' allow an 'open call' mechanism where CS and industry co-design and co-propose a demonstration project to Space for IDA. See Figure 11 right side.

Agriculture and Rural Development
Efficiency

OECD DAC state 'Efficiency' measures the outputs – qualitative and quantitative – in relation to the inputs. It is an economic term which signifies that the aid uses the least costly resources possible in order to achieve the desired results.[58]

Was the project implemented in the most efficient way compared to alternatives?

There is no formal value for money analysis, such as cost-effectiveness or cost-benefit analysis, in the project. However, multiple mechanisms were used to minimise costs and ensure value for money:

- Use of free EO data whenever possible, for example ESA Sentinel or NASA Landsat,
- The EO products have been delivered from the consortium with a 'demonstration rate/cost', whereas normal commercial rates would be higher. The consortium managed expectations by clearly communicating the actual, non-discounted rates outside of the ESA project,
- The consortium maximised value for money by re-using of existing tools and platforms such as FAO WaPOR portal[59] which monitors water productivity,
- The consortium agreed a common platform 'a one stop shop' for all IFI demonstration projects, by pooling resources with complementary initiatives such as Dutch G4AW in Uganda and Burkina Faso,
- The consortium supported the World Bank to assess losses to agricultural production in Syria due to the conflict. Because the country has remained inaccessible, the study relied heavily on satellite EO based analysis, which were cost-effective and safe, compared to ground teams,[60]
- To be cost-efficient the consortium designed a capacity building package to suit all IFI service requirements e.g. the capacity building materials are made publically available via a web portal,
- The consortium recommended to the IFIs and CSs to pool their resources for the EO data, to ensure multiple projects under the IFIs umbrella was not purchasing the same EO data or services.

— *Alignment of resources/match funding*

It is notable that the consortium voluntarily invested financially over and above the ESA grant even though there was no match-funding requirement. This was because they identify the strategic, commercial opportunity that will arise from providing EO products to IFIs and CSs.

The consortium recommends that the future Space for IDA programme should have a requirement for IFIs and CSs to align resources/match fund against any ESA grants. However, the consortium recommends that the industry suppliers should not be required to align resources/match fund. This is because match funding contributions are intended for research and development projects (to support the development of services) and not for the provision of service levels; the competitive bids already ensure a good price-quality ratio.

58 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed December 2018.

59 FAO. 'WaPOR'. https://wapor.apps.fao.org/home/1. Accessed November 2018.

60 ESA. 'Agriculture and Rural Development Cluster – Syria'. https://www.eo4idi.eu/sites/default/files/publications/eo4sd_syria_final.pdf. Accessed February 2019.

— *Cost-effectiveness of using EO for agriculture and rural development*

The project was not required to complete a formal value for money analysis, such as cost-effectiveness analysis (CEA) or cost-benefit analysis (CBA). However, the assumption is that EO has unique strengths in collecting environmental information compared to planes, UAVs or ground-based teams, including:[61]

- collection of data at regular frequency (temporal resolution),
- collection of data over large areas (scale) and in remote, inaccessible areas,
- fast turnaround of data (supporting in-year use),
- lower average data processing costs (through automated processes),
- consistency of data collected multiple times across a long time-series,
- objectivity and lack of human error or bias in data collection,
- re-use potential of the data for other applications. A satellite can monitor land use across any country far cheaper than using ground teams. As a result, EO is suitable for providing the monitoring data that underpin agricultural applications in both developed and the developing world – often more cost effectively than other methods. The UK Space Agency International Partnership Programme is conducting a robust cost-effectiveness analysis of their six agriculture projects, led by Caribou Space and London Economics, which will be published in 2019.

Were objectives achieved on time?

There was a 3–4 month timeline slippage in the first year, due to slow initial engagement from the IFIs at the start of the project. Interaction with new stakeholders takes time to build confidence and trust. The customer journey for an IFI or CS to mainstream EO products is long with multiple stages,[62] with the initial 'Awareness' and 'Consideration' stages being difficult and slow. Also, the IFIs have project timelines that are different and not in the control of the consortium.

Since the first year there has been no timeline slippage. One demonstration project was actually speeded up and brought forward from year two and three, into the first year. This was an assessment of the post-conflict agricultural production in Syria – which was seen as a top priority by WBG.

BOX 9: Efficiency lessons for EO4SD (current) and Space for IDA (future) programmes.

Need for increased alignment of resources/match funding from IFIs and CSs

a) **EO4SD:** None

b) **Space for IDA:** The consortium recommends a requirement for IFIs and CSs to align resources/match fund but not for industry consortiums.

Need for expectation setting of costs/rates for demonstration versus commercial projects

a) **EO4SD:** For consortiums providing discounted rates for their EO products this should be clearly communicated to IFIs and CSs to manage cost expectations.

b) **Space for IDA:** Same as above

61 UK Space Agency and Caribou Space. 'Space for Agriculture in Developing Countries'. https://www.spacefordevelopment.org/library/space-for-agriculture-in-developing-countries/. Accessed December 2018.

62 Awareness, Consideration, Acquisition, Procurement, Loyalty

Agriculture and Rural Development
Impact

OECD DAC state that 'impact' is the positive and negative changes produced by a development intervention, directly or indirectly, intended or unintended. [63]

What has happened as a result of the project? What are the outcomes and impacts?

The project will lead to both short-term and long-term outcomes[64] and ultimately to long term impacts.[65] The short-term outcomes are for the project's direct beneficiaries, the IFI and CS stakeholders in the agricultural and rural development domain. Influencing these stakeholders is the main focus for the project and these short-term outcomes are well defined and evaluated below.

The long-term outcomes are those for the indirect beneficiaries within the zone of influence of the project, e.g. the local farmers, which the project does not have direct influence over. These long-term outcomes are less well defined and are not within the project scope to evaluate. However, it is possible to qualitatively state what the long-term outcomes would be, as per Figure 12.

Equally, the long-term impact, stated in the SoW as the Cardinal Requirement (copied below) is not evaluated for the same reason.

> *'integrate Agricultural and Rural Development EO-based products & services as 'best-practice' environmental information in the planning and implementation of the development projects, programmes and activities of the IFIs, together with their respective CSs'*

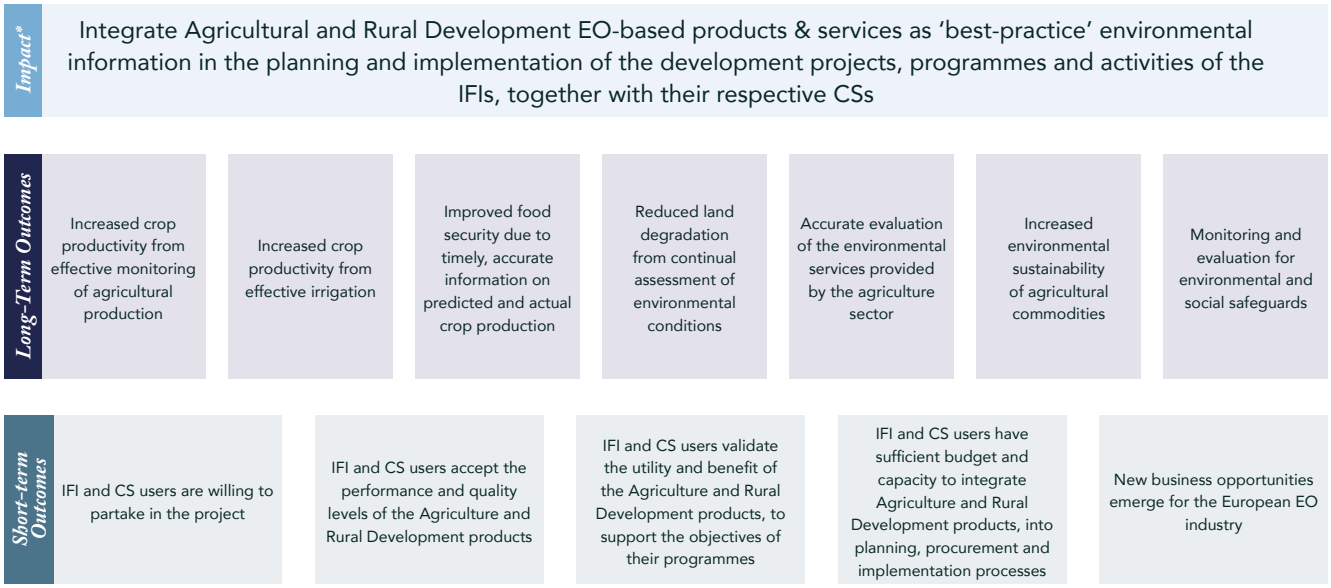

FIGURE 12: Outcomes and impact of the Urban Development project [66]

*SoW Cardinal Requirement

63 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed December 2018.

64 The likely or achieved short-term and medium-term effects of an intervention's outputs.

65 Positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended.

66 Caribou Space

— *Evaluation of short-term outcomes*

To achieve that primary outcome/result the following supporting outcomes need to occur. These are in order of the customer journey in the adoption of EO products:

1. IFI and CS users are willing to partake in the demonstration project,
2. IFI and CS users accept the performance and quality levels of the Agriculture and Rural Development products,[67]
3. IFI and CS users validate the utility and benefit of the Agriculture and Rural Development products, to support the objectives of their programmes,[68]
4. IFI and CS users have sufficient budget and capacity to integrate Agriculture and Rural Development products, into planning, procurement and implementation processes,
5. New business opportunities emerge for the European EO industry.

The short-term outcomes 1, 2 and 3 are assessed below, whilst the sustainability related outcomes 4 and 5 are assessed in Sustainability section.

— *Short-term outcome 1 IFI and CS users are willing to partake in the project*

The IFIs and CSs have been very willing to partake in the project. Four IFIs have been engaged across eight countries. In Cambodia alone, the project has engaged with three individual ADB programmes. In total, 19 IFI programmes worth US$2.7 billion are involved – highlighting the significant development finance that the project is leveraging against.

— *Short-term outcome 2 IFI and CS users accept the performance and quality levels of the Agriculture and Rural Development products*

The Service Delivery Operations Assessment (D11) (October 2018) was a detailed and robust analysis of the performance and quality levels of the products for each of the demonstrations – to answer, 'did the products work?'. This deliverable tracked the progress of each of the EO products and identified the status of the product, issues and mitigations for the long-term and large-scale assessment and monitoring systems for the SAWAP/GGWI areas, are shown as an example, in Table 1.

The conclusions were that for all stakeholders the delivery of the services is on track and according to schedule. The exchange of data works fine in general, but it turned out that the local infrastructure of some stakeholders is weak, especially with regard to storage capacity and/or internet connection – infrastructure development like cloud services would ease the data handling. Also, the scarce availability of field data for training and validation was recognised as a limiting factor and several stakeholders have included funds for field data collection in their budget to support EO4SD activities.

TABLE 1: An example production and delivery assessment for one of the consortium's EO products

TR2.SW.1: Productivity: Vegetation Dynamics (Long Term Trends)

	Category	Status	Issues	Mitigation & impact
Production	Input data	**MODIS NDVI 16d time series 2010-2016** Finished	#1: Cloud coverage	#1: Quality flags were used to remove cloudy pixels.
	Production Environment	The products were processed at DHI GRAS	None	None required
	Thematic content	The thematic contents were produced according to user requirements	None	None required
	Timeliness		None	None required

67 Via a formal institutionalised framework between to ESA and the IFI. This is highlighted to clarify that the consortiums contractual relationship is with ESA, instead of the IFIs and Client States.

68 Ibid.

Delivery	Schedule	**Vegetation Dynamics 2010-2016** *Recipient:* OSS *Due date:* 05/2018 *Status:* Delivered	None	None required
	Format	Raster (GeoTIFF)	None	None required
	Distribution channel	Lizard/ftp	None	None required
	Metadata	Metadata available on Lizard	None	None required

— *Short-term outcome 3*
IFI and CS users validate the utility and benefit of the Agriculture and Rural Development products, to support the objectives of their programmes

The Service Delivery Utility and Impact Review (D12) (October 2018, to be updated and delivered in October 2019) reviews the feedback from the stakeholders on the utility, impacts and benefits perceived from the delivery of EO products during the demonstration period. To obtain the feedback from the stakeholders, detailed questionnaires were provided, followed by dedicated meetings/calls. The IFI and CS user feedback was captured in terms of technical issues, content of EO products, impact and benefit and summary value statements, including:

> *'The demo service is very beneficial because it allows interactive visualisation and provides access to graphics that show trends; it is a cost-effective way of knowing what is going on over different time periods.'*

> *'EO4SD has been an eye-opener for me in terms of recognizing that there are other things out there. I wish I could say that one or two of the EO4SD derived products has been fully adopted – however the products are relatively expensive, and it was not clear how the products would address existing information gaps.'*

> *'EO4SD introduced the satellite-based information collection and analysis to our project and partners. That was an eye breaker for me to think about the use of such information to document our base line and develop a monitoring system.... These data I got help me to demonstrate how satellite data, analyzed and interpreted can have a meaningful information for policy makers.'*

> *'EO4SD products provide high quality data on the 32 communes and the 12 intervention forests of the PIF. The most useful data are those relating to forest and plant cover, rainfall, soils, etc. This free and available data makes it possible to plan and follow the actions of the program…'*

> *'OSS is benefiting from the EO4SD project, tools and geospatial data (such as biomass, evapotranspiration, vegetation dynamics, etc.) developed using Earth Observation resources. Such products have been very useful in the context of the BRICKS project and other projects implemented by OSS'.*

The primary difficulty faced by IFI and CS users was in terms of EO and GIS technical skills which limits adoption and uptake. Lack of IT equipment or internet connectivity was not raised as a challenge, as the main users in IFIs and CSs are in urban office locations.

BOX 10: Impact lessons for EO4SD (current) and Space for IDA (future) programmes. N.B. Same note as for Relevance Lessons

Maximise impact by ESA investing in public domain EO products for specific domains

a) **EO4SD:** None

b) **Space for IDA:** ESA and IFIs invest in public domain EO products for specific domains similar to FAO Water Productivity Open-access portal (WaPOR) where industry provides the service levels to ensure effective collaboration between ESA and industry. However, duplication of scope should be checked against ESA's Thematic Exploitation Platforms.

Agriculture and Rural Development
Sustainability

OECD DAC state that 'sustainability' is concerned with measuring whether the benefits of an activity are likely to continue after donor funding has been withdrawn. Projects need to be environmentally as well as financially sustainable. [69]

What activities did the project execute to ensure the benefits of the project continue after donor funding ceased?

The Agriculture and Rural Development project has a strong objective that is long term adoption of the products to ensure the development impacts of the project continue after the funding ends. The main tools for this are the Stakeholder Engagement and Capacity Building Plan (CBP) (D4), a Communication Package (CP) (D5) and an EO Service Cluster Mainstreaming Roadmap (D13).

— *Stakeholder Engagement and Capacity Building Plan*

Was tailored to the specific needs of the main stakeholders including IFIs, CS and the various (inter)national governmental, and non-governmental, organisations involved in the projects financed by the IFIs. The capacity building plan for these stakeholders aims to increase the human and institutional capacity at the county/regional levels by providing training for EO/GIS professionals to assist them in fulfilling their operational functions. The courses are coordinated by the ITC Faculty of Geo-Information Science and Earth Observation of the University of Twente – a global leader in training and capacity building in the field of geo-information science, EO and GIS and delivered by ITC and the service providers based on the respective topic and required expertise. The capacity building activities for each stakeholder was based on:

- their operational information needs in relation to EO products,
- their existing level of EO/GIS knowledge and expertise,
- their preferences concerning the duration and type of the capacity building activities to fit their operational practices.

— *Customer journey*

The consortium has mapped out a customer journey (see Figure 13) highlighting the staged progress from Awareness to Consideration to Acquisition to Procurement to Loyalty for IFI (HQ and Country Offices) and CS stakeholders' adoption of EO products. This customer journey was used to customise capacity building depending on the stage and progress of the stakeholders through the customer journey.

FIGURE 13: Customer journey in adoption of EO products by IFIs and CSs

69 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed December 2018.

— *Capacity building workshops*

Week long capacity building events, focused on CS stakeholders, have been held in Cambodia (60 attendees), Ethiopia (31 attendees), Morocco (eight attendees), Uganda (eight attendees) and Bolivia (ten attendees). The agenda varied for each workshop but broadly consisted of a high-level overview of EO4SD, overview of EO for the agricultural and rural development domain broadly, overview of EO for M&E, state of the art data and tools and a run through of relevant ESA projects such as Sen2Agri. This was complemented with in depth theory and practical GIS and EO training, in depth overviews of the products, round table discussions.

In general, the workshops have fulfilled their immediate objectives in terms of capacity building on EO and GIS, and on creating awareness amongst the participants on the potential of EO based information in general, and on the capacities in this context of the project partners in particular.

However, the results of the assessments also indicate that much more needs to be done to achieve an operational inclusion of EO based information as a complement to other sources of information, in the daily routine and working processes of the relevant national and regional stakeholders. Specifically, this relates to the currently still weak recognition at high management levels of the potential of EO based information to complement traditional information sources, which is demonstrated by the fact that the use of EO information does not often appear in policy documents and consequently not in the regular budgets.

— *InfoSessions*

A unique capacity building element compared to other EO4SD projects are for the IFIs to build awareness on the utility and potential benefits of EO for agriculture and rural development at InfoSessions. These have been held at ADB in Manilla, IFAD in Rome and WBG in Washington DC. A feedback survey from the ADB event highlighted that the workshop gave the attendees a good overview of what can be expected from EO and they left with a better understanding of the value add of EO to their projects. The InfoSessions will be repeated in 2019 highlighting results and follow-up, providing an opportunity for ESA to showcase future plans. The InfoSessions have proved crucial in achieving top down IFI engagement to complement the bottom up engagement with the individual programmes and their staff. Having the headquarter offices involved supports the mainstreaming of EO in the IFI policies.

— *Online learning courses*

Training materials are made available online via a portal. Full service demonstrations are made available using the Lizard platform to share the project tutorials and results with the stakeholders and a wider virtual audience. These are managed by ITC University Twente and participants obtain formal certification.

— *Communication Package*

Whilst the CBP is focused on a highly targeted, finite audience, the Communication Package (D5) allows the Agriculture and Rural Development project to raise awareness, share results and learnings to a broader audience. The consortium conducted a Communications Effectiveness Review (D6) to assess the effectiveness of the communications channels and meetings – identifying additional measures, or changes in the communications activities if required to improve them.

The following communication channels were used:

- a project website, with over 5,000 unique page views between July 2017 and July 2018, and parallel social media through the Copernicus Twitter (28k followers). This includes a knowledge portal summarising the potential uses of EO technology in smallholder agriculture, [70]
- a monthly/bi-monthly newsletter (from year two) to inform stakeholders on the latest project information,
- a general-purpose hard-copy brochure summarising the products,[71]
- service description sheets that provide a list of the state-of-the-art EO products available to support agricultural monitoring and management,[72]
- an interactive application portal that demonstrates the products,[73] and provides actual data,[74]

70 ESA. 'EO4SD – KNOWLEDGE PORTAL'. https://www.eo4idi.eu/eo4sd-knowledge-portal. Accessed December 2018.

71 ESA. 'Agriculture and Rural Development | Service Portfolio'. https://www.eo4idi.eu/sites/default/files/eo4sd_agri_portfolio_170529_singlepag.pdf. Accessed November 2018.

72 ESA. 'Portfolio'. https://www.eo4idi.eu/#portfolio. Accessed December 2018.

73 EO4SD Demo. https://eo4sd.lizard.nets. Accessed November 2018.

74 ESA. https://eo4sd.lizard.net/. Accessed December 2018.

- country brochures highlighting the country demonstrations,[75]
- publication in 'A Better World Vol. 4',[76]
- attendance at conferences e.g. Asia Water Forum, Land and Poverty 2018 and 2019 Conference and AARSE 2018,[77]
- promotion through other organisations blogs and publications including IFAD,[78] Satellite Earth Observations in Support of the Sustainable Development Goals[79] and World Agroforestry Blog.[80]

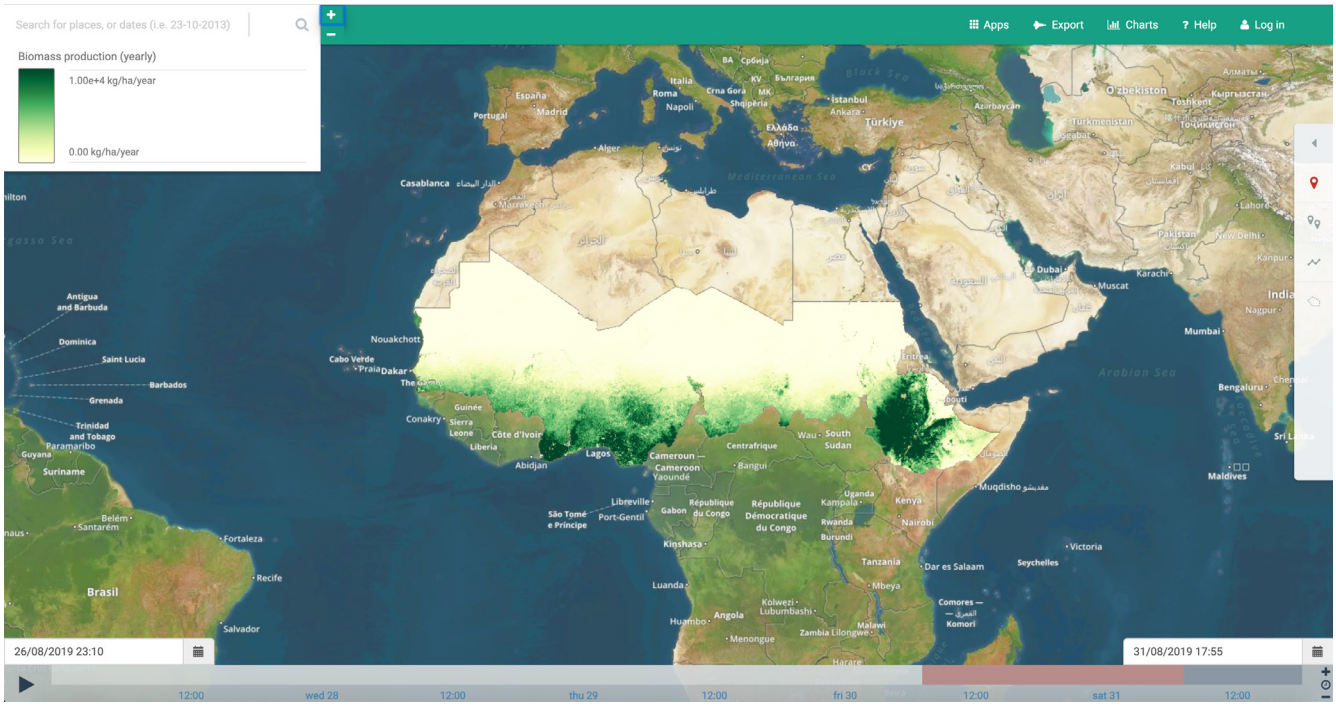

FIGURE 14: Potential difference in procurement mechanisms between EO4SD and Space for IDA Activity 1: Knowledge Development

— *Local offices and local private sector involvement*

Establishing collaboration agreements with local offices and private stakeholders represent an important aspect of the overall project objective for achieving long-term sustainability. Local partners in Africa have been identified to further promote the consortium's EO products to local potential customers including an SME Aquagri (Morocco), MUIIS[81] (Uganda) and World Agroforestry Centre (ICRAF) (based in Kenya supporting all Africa activities). In LatAm and Asia the consortium has been unable to find appropriate and willing partner organisations and have identified local consultants instead to support on hosting capacity building events, maintaining regular contact with the stakeholders and reaching out to new customers.

— *EO Service Cluster Mainstreaming Roadmap*

An EO Service Cluster Mainstreaming Roadmap (D13) for the long-term use of EO products both within the IFI working practices and within the CS, will be completed at the end of the project in October 2019 (month 36).

75 ESA. 'Publications'. https://www.eo4idi.eu/publications. Accessed December 2018.

76 Tudor Rose. 'A Better World Volume 4'. http://digital.tudor-rose.co.uk/a-better-world-vol-4/4/. Accessed December 2018.

77 ESA. 'Events'. https://www.eo4idi.eu/events. Accessed December 2018.

78 IFAD. 'IFAD SOCIAL REPORTING BLOG'. http://ifad-un.blogspot.dk/2018/02/eo4sd-agriculture-and-rural-development.html. Accessed December 2018.

79 ESA. 'SATELLITE EARTH OBSERVATION IN THE SUPPORT OF THE SUSTAINABLE DEVELOPMENT GOALS'. http://eohandbook.com/sdg/index.html. Accessed January 2019.

80 Agroforestry World. 'Global Environment Facility's Integrated Approach Programme on food security gains momentum'. http://blog.worldagroforestry.org/index.php/2018/06/08/gef-funded-integrated-approach-programme-on-food-security-gains-momentum/. Accessed January 2019.

81 Market-led, User-owned ICT4Ag-enabled Information Service (MUIIS) is an innovative project that harnesses the power of satellite data to support extension and advisory services to farmers in Uganda.

To what extent did the benefits of the project continue after donor funding ceased?

There are two specific short-term outcomes related to sustainability as assessed below:

— ***Short-term outcome 4***
IFI and CS users have sufficient budget and capacity to integrate Agriculture and Rural Development products into planning, procurement and implementation processes

Capacity Building Activities Review (D10) assessed the effectiveness of the Capacity Building Workshops and InfoSessions and gained feedback to improve future sessions. Also, a Stakeholder Engagement Review (D13) assessed progress of the IFIs and CSs with regard to the integration of EO derived information into existing/future Official Development Assistance (ODA) activities. It included a baseline, a mid-term assessment and will include a final assessment. It assesses the evolution in awareness and acceptance of EO products and it documents the scope and effectiveness of capacity building and communication activities.

A largely positive attitude towards EO has been observed among the majority of stakeholders, from the technical level to the higher decision-making levels. Consequently, a change can be perceived towards an increased uptake and integration of EO products. The project has significantly contributed to enhancing the awareness on and appreciation of the benefits and advantages of EO products within IFIs and CSs. EO is acknowledged as a cost-efficient tool that contributes to the optimisation of the implementation, or extension, of existing projects as well as to the development of projects in the future. However, while consensus is shared that the EO products were useful, they have largely not been integrated into existing working processes, primarily due to, a) the lack of a dedicated institutional backing, b) the need for long term budgets, and c) inadequate technical infrastructure and expertise.

— ***Short-term outcome 5***
New business opportunities emerge for the European EO industry

The consortium has generated numerous spin-off activities, which are new opportunities (from concept notes to operational implementation) that emanate from the ESA project. These are a strong indicator of success of both the capability of the consortium and the increased interest in the IFIs and CSs to procure EO products. These include opportunities in Asia (Bangladesh, Nepal, Sri Lanka), Africa (Eretria, Ethiopia and Niger), Middle East (Iraq) and Central Asia (Armenia). The consortium is also in discussion with an organisation in Kenya that wishes to become a local re-seller for the their EO products.

Finally, through the formation of the consortium, the eight-member European organisations have become aware of each other's capabilities allowing them to work together on future opportunities outside the project.

What were the major factors which influenced the achievement or non-achievement of sustainability of the project?

— *Positive factors*

Champion users – Were identified, who were the most engaged and enthusiastic IFI users to support the capacity building activities. Extra emphasis was placed on engaging them to ensure they have a positive influence within the IFIs, for example, by explaining to colleagues the benefits of EO. Champion Users are invited to present at the Capacity Building Workshops and InfoSessions.

Lack of data for reporting progress of UN SDGs – The 2030 Agenda for Sustainable Development clearly stressed the importance of Geospatial Information and EO for countries to monitor and report against the SDG Targets and Indicators. EO is global, comprehensive, accurate, repeatable and timely, and therefore is a critical source of data to monitor progress to the SDGs – and therefore is a factor that will drive the long-term adoption of EO for IFIs and CSs.

— *Limiting factors*

Embedding of EO into IFIs strategic planning to ensure senior buy-in and budget allocations – IFIs and CSs highlighted the need for awareness raising at higher-seniority levels to spark interest and enthusiasm about EO within the higher levels of their organisations. In particular to ensure a) budget availability for EO information, b) budget availability for in-situ monitoring, as an essential underpinning of EO information, c) awareness at a technical level on the intrinsic quality and possibilities of EO based information, in comparison to in-situ information,

and d) strengthened data management in IFI and CS organisations as a prerequisite for a smooth integration of EO information.

For the EO4SD project, IFIs have covered the hosting and logistics costs for the Capacity Building Workshops and InfoSessions. They have also contributed human resources as the IFI TTLs and provided teams to gather field data. For the long term, IFIs have indicated some willingness to invest in EO services and technical human resources, albeit this would largely need to be at an institutional level rather than project level. CSs are more apprehensive in terms of investing in EO services, primarily due to the limited IT infrastructure, limited technical capacities and cost considerations.

Access to technical expertise and infrastructure

– Technical expertise is limited and fragmented, particularly at higher levels, and this makes stakeholder organisations particularly vulnerable to staff changes and changing political priorities. Equally the IT infrastructure to download, process and store large EO datasets is not common across all IFIs and CS organisations.

However, it would not be suitable for all IFI and CS organisations to invest and build internal technical expertise and infrastructure as that would require significant budget and time and would lead to duplication of efforts across those organisations. Instead the IFIs and CSs should be able to assess what is effective and efficient to do internally and what should be outsourced to external EO service providers, like the project consortium members.

BOX 11: Sustainability lessons for EO4SD (current) and Space for IDA (future) programmes.

Embedding of EO into IFIs strategic planning to ensure senior buy-in and budget allocations

a) **EO4SD:** Senior level engagement from the IFIs to institutionalise EO in the processes of the IFIs strategic planning is essential to transcend individual programme/project level. A regular reporting/updating mechanism from EO4SD, including the consortium primes, ESA and IFI senior management, for example roundtable briefings, could be valuable.

b) **Space for IDA:** Space for IDA Option 2: New Trust Fund and Joint Work Programme will require senior IFI management agreement (including Global Practice Managers) and they can be regularly updated through a quarterly (or other) reporting cycle from ESA.

Access to technical expertise and infrastructure

a) **EO4SD:** For the remaining un-contracted projects (i.e. Forest Management, Ecosystems Services) ensure their capacity building related work packages/deliverables include training on the scenarios and advantages/disadvantages for IFIs and CSs to utilise EO products along a spectrum from inhouse to outsourced.

b) **Space for IDA:** In Activity 2: Capacity Building including training on the advantages/disadvantages and optimal scenarios for IFIs and CSs to utilise EO products along a spectrum from inhouse to outsourced.

Water Resource Management

Water Resource Management

The EO4SD Water Resources Management project aims to demonstrate the benefits and utility of EO services in response to stakeholder requirements for water resources monitoring and management at local to basin scales.[82] It will provide EO demonstrations on a large-scale in Africa (Sahel, Africa Horn and Zambezi), Asia (Myanmar and Lao PDR) and Latin America (Bolivia and Peru), and within water related operations of major IFIs including WBG, ADB, IADB and the GEF.

The use cases it will support are:

- River basin characterisation and change monitoring (e.g. hydrological network mapping, long-term climate change analysis),
- Water supply and sanitation (e.g. monitoring of water quality, extent and level of lakes and rivers to support management for agricultural, industrial and urban water use),
- Hydrological management (e.g. modelling and forecasts of runoff, river discharge and groundwater abstraction),
- Water productivity (e.g. mapping of biomass production, evapotranspiration and crop type),
- Risk management of natural hydrological hazards (e.g. mapping and forecasting of flooding, drought, landslides),
- Industrial activity assessment (e.g. monitoring of freshwater fisheries, aquaculture, hydropower and mining).

82 ESA. 'water resource management.' http://eo4sd-water.net/. Accessed December 2018.

Water Resource Management
Relevance

OECD DAC state 'Relevance' is focused on the extent to which the aid activity is suited to the priorities and policies of the target group, recipient and donor.[83]

To what extent are the objectives of the project still valid?

Today, most countries are placing unprecedented pressure on water resources. The global population is growing fast, and estimates show that with current practices, the world will face a 40% shortfall between forecast demand and available supply of water by 2030.[84]

Global water resources are being rapidly exploited through unprecedented population growth and widespread unsustainable management practices. The current pace, magnitude and spatial reach of humankind's impact on water resources is now a very real concern for future development and peace. In simple terms this means that water resources are being polluted and over-exploited on scales never witnessed before. Currently, millions of people still live without access to safe drinking water, mainly in sub-Saharan Africa and Asia.[85]

Agricultural irrigation remains by far the largest consumer of freshwater resources, accounting for about 70% of freshwater use.[86] Feeding nine billion people by 2050 will require a 60% increase in agricultural production.[87]

Water security is a major – and often growing – challenge for many countries today. It is a transboundary issue with 276 transboundary basins, shared by 148 countries, and 300 aquifers systems are transboundary.[88]

In response to the widespread recognition of impending water scarcity, in January 2015, the World Economic Forum (WEF) declared the water crisis as one of the highest global risks. However, despite this growing concern, a water crisis can be viewed as management crisis, that can be mitigated through the application of best-practices and sound water resource management policy. At the global level UN SDG 6 has set targets for 'availability and sustainable management of water and sanitation for all'.

One of the central pathways outlined to achieve this goal is through integrated water resources management (IWRM) at multiple levels, including transboundary cooperation (SDG Target 6.5). The successful implementation and monitoring of IWRM initiatives require access to reliable data and information on key water related challenges.[89] Examples of strategies to manage transboundary and national water issues include the Integrated Water Resources Management (IWRM) Strategy for the Zambezi River Basin (ZAMSTRAT), and the National Water Policy of Myanmar aiming to apply IWRM for sustainable development.

There is now a growing awareness that EO has the potential to serve these data needs. This is especially relevant in the context of ODA, which normally target regions where policies and management decisions are more often based on sparse and unreliable information.

83 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed December 2018.

84 World Bank. 'WATER RESOURCES MANAGEMENT'. http://www.worldbank.org/en/topic/waterresourcesmanagement. Accessed November 2018.

85 ESA. 'water resources management'. http://eo4sd-water.net/. Accessed November 2018.

86 Ibid.

87 World Bank. 'WATER RESOURCES MANAGEMENT'. http://www.worldbank.org/en/topic/waterresourcesmanagement. Accessed November 2018.

88 Ibid.

89 ESA. 'water resources management'. http://eo4sd-water.net/. Accessed November 2018.

Are the activities and outputs of the project consistent with the overall goal and the attainment of its objectives?

The Water Resource Management project has three deliverables (D1, D2 and D3) that ensure project outputs, partners and countries were relevant to the objectives through extensive engagement with IFIs and CSs.

— *Relevance of project outputs*

The Strategic Plan (D1) provided the framework for guiding all activities. This included a rigorous analysis of existing IFI water management programmes to prioritise those for collaboration on a range of factors.[90] It also included the scope of EO products, the IFI programmes to be addressed and on-going complementary initiatives to cooperate with.

The Client State & Stakeholder Capabilities Assessment (D2) identified the stakeholders, assessed their importance and influence and their capabilities in using EO. This analysis categorised ~210 organisations into four distinct types, that allowed customisation of the stakeholder engagement and capacity building/ training plan.

The Service Cluster Portfolio Specifications (D3) specifies the EO products to be generated and the expected benefit and impact of them. For 12 EO products it provided use cases, known limitations, future enhancements and other related EO products. The consortium of nine organisations[91] had complimentary expertise and split their responsibilities across the service portfolio and also the geographic regions.

The user requirement process included a literature review and meetings with the IFIs to identify potential priority river basins/countries. This was supplemented with visits to the potential countries to discuss directly their key water issues with project stakeholder holders and key beneficiaries and where possible trying to position EO as a monitoring tool for those issues. Typically, two visits were required: first for collection of broad user requirements and a second for consolidation and refinement.

BOX 12: Water Resources Management Service Portfolio

Water Resources Management Service Portfolio

- Surface water monitoring
- Water quality and temperature monitoring
- Monitoring crop and vegetation water demand
- Hydrological modelling and monitoring
- Hydrological network mapping
- Natural risk management
- Groundwater mapping and exploitation
- Industrial activity assessment
- Vegetation and land cover characterisation
- Settlement characterisation
- High resolution digital elevation models
- Thematic base mapping

— *Relevance of project geographies*

The selection of countries was made through a two-stage process. In the ESA SoW there was an initial list of recommended countries, across Africa, Latin America and Caribbean, and Asia, following preliminary discussions with existing IFI partners. The country selection was then refined by the consortium during the first year via further consultation with the IFI and CS partners. Figure 16 shows the selected countries.

90 a) Challenges identified as "priority areas" for Earth Observations, b) Timing to fit with EO4SD timeline. Projects where Earth Observation is not or only partly included according to the existing project document, c) An operational project implementation organisation in the country with whom the ESA consortium can interact and strengthen its capacity, d) Possibilities to disseminate results and lessons learned to a broader forum, e) Agreements from responsible authorities in the respective countries as well as from the IFIs.

91 DHI GRAS (Denmark) (lead), GeoVille (Austria), Satelligence (The Netherlands), Starlab (Spain), eLEAF (The Netherlands), DHI (Denmark), adelphi (Germany), University of Twente – ITC (The Netherlands), DTU Environment (Denmark)

	Surface water monitoring	Water quality and levels monitoring	Monitoring of crop water demand	Hydrological modelling and monitoring	Hydrological network mapping	Natural risk management	Groundwater mapping and exploitation	Industrial activity assessment	Vegetation and land cover characterisation	Settlement characterisation
Africa										
Zambezi River Basin Management Project	●	●	●			●				
Sahel Irrigation Initiative Support Project	●		●				●			
Regional Ground Water Initiative on Africa Horn	●			●			●			
Asia										
Ayeyarwady Integrated River Basin Management Project					●	●			●	●
Irrigated Agriculture Inclusive Development Project			●	●		●				
Sustainable Rural Infrastructure and Watershed Management Project				●		●			●	
Latin America										
Irrigation Program with a Watershed Approach (III)			●							
Integrated Water Resources Management in Ten Basin	●	●								
IWRM in the Titicaca-Desaguadero-Poopo-Salar de Coipasa System		●								

FIGURE 15: Summary of services requirements for each IFI programme

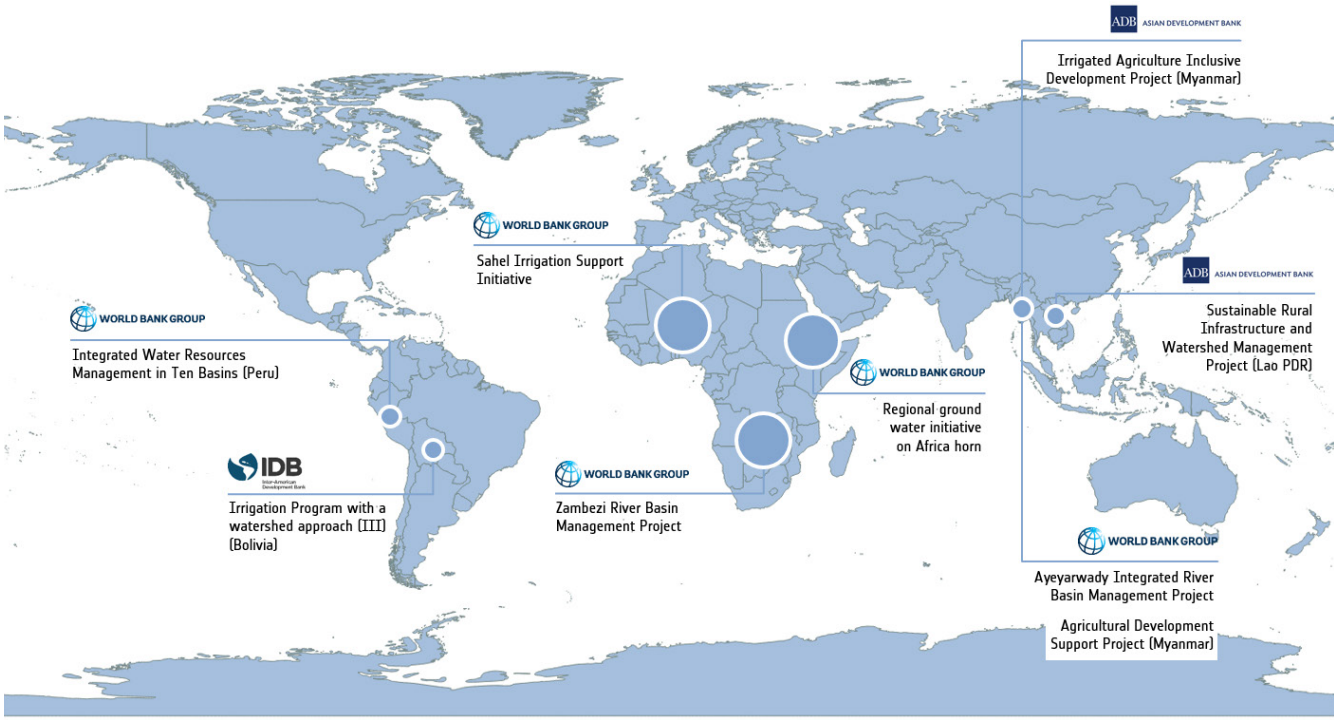

FIGURE 16: Selected countries and IFI partners in Latin America, Africa & Asia [92]

92 Additionally in Bolivia/Peru there is the Integrated Water Resources Management in the Titicaca-Desaguadero-Poopo-Salar de Coipasa (TDPS) System programme

The selection of project partners is consistent with the overall goal and the attainment of its objectives. Engagement of IFI and CS stakeholders is critical in order to increase the uptake of EO products and mainstream these within IFI operations. The IFIs were selected based on both the existing relationship and MoIs with ESA and their existing water management programmes. The comprehensive Strategic Plan (D1) reviewed the main IFI and non-IFI agencies involved in water management. In the CS the consortium engaged with national stakeholders such as the local governments, water authorities, local research institutions and technical centres. Also, the consortium identified in their Strategic Plan (D1) a list of related regional initiatives for collaboration including actual provision of EO services, cooperative capacity building or joint communication awareness raising.

At an international scale, they engaged with organisations responsible for trans-boundary coordination and management of major rivers including Zambezi Watercourse Commission (ZAMCOM), Nile Basin Initiative (NBI), Lake Chad Basin Commission (LCBC), Niger Basin Authority and SERVIR West Africa and Mekong. At a continental scale, engaged organisations included GlobWetland Africa and GMES & Africa (in Africa),[93] African Ministers' Council on Water (AMCOW) and the Asian Water Forum (AWF). Finally, at a global scale, engaged organisations included the UN FAO Remote Sensing for Water Productivity, the GEMS/Water-Programme and the International Waters Learning Exchange and Resource Network (IW:Learn).

BOX 13: Relevance lessons for EO4SD (current) and Space for IDA (future) programmes

No specific relevance lessons from from Water Resources Management project

93 Supported by ESA and the Africa Commission

Water Resource Management
Effectiveness

OECD DAC state 'Effectiveness' is a measure of the extent to which an aid activity attains its objectives. [94]

To what extent were the objectives achieved / are likely to be achieved?

— *Achievement of Work Requirements*

The ESA SoW had 21 Work Requirements (WRs), which specify the contractual requirements the consortium has to deliver. A detailed analysis of the achievement of these was provided by the consortium; with eight months remaining the majority of WR's have been achieved.

See the Impact and Sustainability sections for a detailed assessment of the outcomes of the project.

What were the major factors influencing the achievement or non-achievement of the objectives?

— *Positive factors*

Consortium team: The consortium performing the project is composed of nine companies/institutions[95] – led by DHI GRAS (Denmark) – with deep and complementary EO technical proficiency and wide experience in developing geo-spatial services in the water domain. A particular advantage for DHI GRAS is being part of the parent company DHI. Roles and responsibilities within the consortium, IFIs and CS were clearly defined in a Service Cluster Test Report (D7).

Appetite within IFIs to adopt EO: Within the water domain the IFI and CSs recognise the potential for EO products, and WBG have published extensive materials on this topic.[96] So the challenge was not to get them onboard but rather to define realistic demonstrations in response to their water challenge, and sometimes level expectations in terms of what can and what cannot be done.

Existing consortium relationships: The consortium had existing relationships with Agrymet and ZAMCOM, and the familiarity allowed DHI GRAS to accelerate the securing of buy-in from those organisations in the early stage.

In country teams: The consortium had people available, from DHI and Satelligence, in country to support the logistics of hosting the capacity building sessions in Myanmar, Bolivia and later this year also in Peru.

ESA secondments: The ESA secondments at WBG and ADB supported the consortium to communicate within the IFIs, providing an interface to the IFI HQs in Washington and Manilla, aiding senior IFI buy-in, coordination and logistical support for the InfoSessions.

— *Limiting factors*

Difficulty aligning to IFI programme timelines: It was difficult for the Water Resources Management timelines to align with those of the IFI programmes, as those programmes start at different times, move at different speeds and are outside the control of ESA and the consortiums. The two broad options are either to enter an ongoing project with the risk of joining too late with limited ability to influence scope or budgeting,

94 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed January 2018.

95 DHI GRAS, DHI, GeoVille, SATELLIGENCE, eLEAF, Starlab, adeplphi, University of Twente, DTU

96 Earth Observation for Water Resources Management. http://documents.worldbank.org/curated/en/783571468196447976/pdf/104778-PUB-Box394885B-PUBLIC-pubdate-4-14-16.pdf. Accessed February 2019.

or alternatively, join a project early with the danger that IFI schedules slip or change – as the consortium experienced in Sahel, Africa Horn, Peru and Lao.

Risk of 'user fatigue' due to overlapping demands across EO4SD projects: There is potential for overlapping scope between different EO4SD projects. The risk for the EO4SD programme broadly is as EO4SD implements all the nine planned domains there may be duplication of effort, and also multiple consortiums may approach the same IFI teams with similar requests – creating confusion, appearance of lack of coordination and user fatigue.

Risk of 'user fatigue' due to non-ESA programmes: The above issues are compounded by the fact there are other non-ESA programmes using EO within a sustainable development context, including UKSA International Partnership Programme (IPP), Dutch Geo-Data for Agriculture and Water (G4AW), and NASA SERVIR, etc.

BOX 14: Effectiveness lessons for EO4SD (current) and Space for IDA (future) programmes

Difficulty aligning to IFI programme timelines

a) **EO4SD:** Allow as much flexibility in the delivery timelines of EO4SD projects as is possible, to align to IFI programme timelines.

b) **Space for IDA:** As IFI programme timelines are outside of the control of ESA, in Activity 1: Knowledge Development, ESA should have very flexible delivery timelines for the industry consortiums, to allow alignment to IFI programme timelines.

Risk of 'user fatigue' due to overlapping demands across EO4SD projects

a) **EO4SD:** The EO4SD team, particularly the secondees at WB and ADB, should identify and mitigate potential points of scope overlap (across EO4SD domains) and the risk of multiple consortium approaches to the same IFI teams.

b) **Space for IDA:** Evolve the 'ESA Secondment' approach to an expanded 'ESA Secretariat' within the IFIs, that would act as a coordinating team/function between the IFIs and the industry consortiums. This would need careful design to avoid disadvantage of consortium primes being 'one step removed' from IFIs, which could cause delays. Also, there could be strong splits in geographic scope dependant on sector.

Risk of 'user fatigue' due to non-ESA programmes

a) **EO4SD:** Continue and strengthen the engagement with similar non-ESA programmes to identify areas of potential overlap and collaboration, particularly where there are activities within the same country and same domain.

b) **Space for IDA:** Same as above.

Water Resource Management
Efficiency

OECD DAC state 'Efficiency' measures the outputs – qualitative and quantitative – in relation to the inputs. It is an economic term which signifies that the aid uses the least costly resources possible in order to achieve the desired results.[97]

Was the project implemented in the most efficient way compared to alternatives?

There is no formal value for money analysis, such as cost-effectiveness or cost-benefit analysis, in the project. However, multiple mechanisms were used to minimise costs and ensure value for money:

- Used free, low resolution Landsat and Sentinel data when possible to address the Water Resource Management use case, with commercial high-resolution data only used when required,
- Reusing existing consortium relationships, e.g. Agrymet and ZAMCOM, accelerated the securing of buy-in from those organisations in the early stage,
- The project is focusing resources for the development and demonstration of EO products in exemplar 'lighthouse' countries for each region, e.g. Malawi for the Zambezi and Niger for the Niger river. These countries act as demonstrations for their neighbours who can adopt the same EO products. Also, within countries exemplar regions were selected including Cochachambo region in Bolivia, Amazonia in Peru and Somaliland/Puntland on Africa Horn.

Were objectives achieved on time?

By the end of year one there was a five-month delay. The project will take an estimated total of 3.5 years, finishing in November 2019, five months late. This is primarily due to difficulty aligning to IFI programme timelines, particularly in getting approvals from the IFIs to start activities to support their programmes. The consortium highlighted that the documentation requirements were significant and used time that might be more efficiently focused on delivery activities. They recommended streamlining documentation requirements whilst still ensuring appropriate planning and tracking, validating work completed and future audit.

97 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed January 2018.

Need for greater flexibility in the ESA SoW regarding the deliverables

a) **EO4SD:** For remaining un-contracted projects (i.e. Forest Management, Ecosystems Services), allow increased flexibility in the response to the SoW regarding the deliverables.

b) **Space for IDA:** For procurement SoWs for 'Activity 1: Knowledge Development', allow increased flexibility in the SoW Annex regarding the required deliverables.

Increase efficiency by streamlining documentation and reporting requirements

a) **EO4SD:** For remaining un-contracted EO4SD projects, aim to significantly reduce the documentation requirement on the consortia including the number of deliverables. Reconsider changing the SOW to a simpler format that allows for more flexible and faster interactions with ESA and the IFIs and less report writing, whilst maintaining high quality of deliverables for the IFIs.

b) **Space for IDA:** For procurement SoWs for 'Activity 1: Knowledge Development', same lesson as above.

With trans-national issues have national exemplar cases ('lighthouses') that serve as a blueprint for the region

a) **EO4SD:** Due to the significant costs for mapping entire transboundary areas, consider focusing resources heavily in 'lighthouse' countries that can act as a guiding example to neighbouring countries that have the same issues, and within countries on specific sub-regions.

b) **Space for IDA:** For Activity 1, 2 & 3, same point as above.

Water Resource Management
Impact

OECD DAC state that 'impact' is the positive and negative changes produced by a development intervention, directly or indirectly, intended or unintended. This involves the main impacts and effects resulting from the activity on the local social, economic, environmental and other development indicators.[98]

What has happened as a result of the project? What are the outcomes and impacts?

The project will lead to both short-term and long-term outcomes[99] and ultimately to long term impacts.[100]

The short-term outcomes are for the project's direct beneficiaries, the IFI and CS stakeholders in the water management sector. Influencing these stakeholders is the main focus for the project and these short-term outcomes are well defined and evaluated below (see 'Evaluation of short-term outcomes').

The long-term outcomes are those for the indirect beneficiaries within the zone of influence of the project, e.g. people living within a rivers water basin, which the project does not have direct influence over. These long-term outcomes are less well defined and are not within the Water Resources Management project scope to evaluate. However, it is possible to qualitatively state what the long-term outcomes would be, as per Figure 17. The benefit of doing this for IFI and CS stakeholders is that they identify how the project will address their day to day challenges and requirements.

Equally, the long-term impact, stated in the SoW as the Cardinal Requirement (stated below) is not evaluated for the same reason.

> *'Integrate Water Resources Management EO-based products & services as 'best-practice' environmental information in the planning and implementation of the development projects, programmes and activities of the IFIs, together with their respective CSs'*

98 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed January 2018.

99 The likely or achieved short-term and medium-term effects of an intervention's outputs.

100 Positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended.

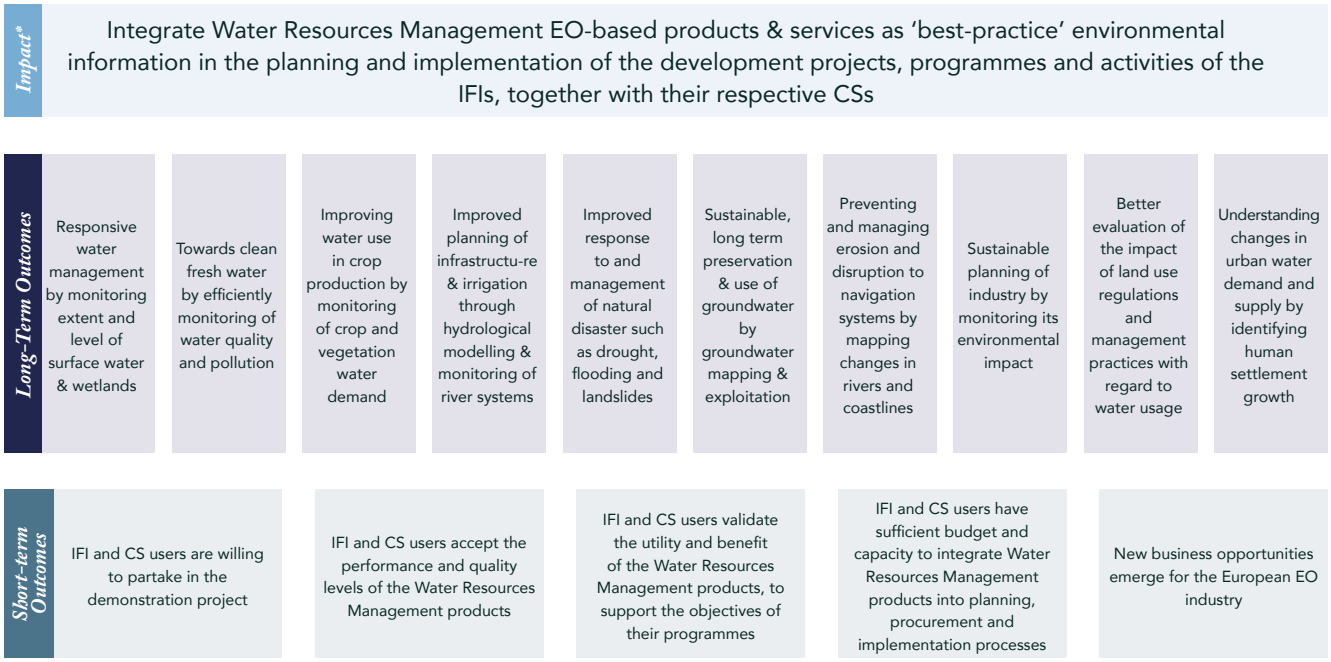

FIGURE 17: Outcomes and impact of the Water Resources Management project[101] *SoW Cardinal Requirement

Evaluation of short-term outcomes

To achieve the above long-term outcomes and the impact, the following short-term outcomes need to occur. These are in order of the customer journey for IFIs and CSs in their adoption of EO products:

1. IFI and CS users are willing to partake in the demonstration project,
2. IFI and CS users accept the performance and quality levels of the Water Resources Management products,[102]
3. IFI and CS users validate the utility and benefit of the Water Resources Management products to support the objectives of their programmes,[103]
4. IFI and CS users have sufficient budget and capacity to integrate Water Resources Management products, into planning, procurement and implementation processes,
5. New business opportunities emerge for the European EO industry.

The short-term outcomes 1, 2 and 3 are assessed below, whilst the sustainability related outcomes 4 and 5 are assessed in the Sustainability section.

— *Short-term outcome 1 IFI and CS users are willing to partake in the demonstration project*

The IFIs and CSs have been very willing to partake in the project. Four IFIs have been engaged across ~25 countries across LatAm, Africa and Asia. In total, nine IFI programmes worth US$680 million are involved – highlighting the significant development finance that the project is leveraging against (see Annex A).

— *Short-term outcome 2 IFI and CS users accept the performance and quality levels of the Water Resources Management products*

The first step the consortium used to ensure users accept the performance and quality levels was to document the Service Cluster Test Report (D7), which defined for all EO products the agreed technical details of the prototypes, associated risks in terms of user capacities and expertise, capacity building measures, and delivery procedures (in effect this is a User Requirements Document (URD)).

The Service Demonstration Exercise Specification (D8) then presents the methodology for testing and acceptance of the Water Resources Management products by the users. For each EO product there was detailed analysis of the rationale for the EO product, the success criteria and measures, the method for

101 Caribou Space

102 Via a formal institutionalised framework between to ESA and the IFI. This is highlighted to clarify that the consortiums contractual relationship is with ESA, instead of the IFIs and Client States.

103 Ibid.

validating accuracy and technical risks and mitigations. The analysis provided very clear and specific measures of success for users to accept the performance levels of the Water Resources Management products.

The Service Delivery Operations Assessment (D11) assessed the performance and quality levels of the Water Resources Management products, by a) ensuring the consortium are delivering the services on time and to agreed standards; and b) to verify that users can access and utilise the EO products as envisioned. This document included for each EO product, an assessment of 'Production summary', 'User access' and 'Measures of success' as per Table 2. This analysis was based on the success criteria and measures defined previously in Service Demonstration Exercise Specification (D8). This provided a robust analysis of whether the EO products had met the required performance and quality levels for users.

The assessment highlighted two key challenges:

— *Need for multiple mechanisms for users to access EO products*

Initially the consortium built a data server to provide the users access to the EO products that included cataloguing and search functionality. However, the usage statistics showed little use by the users who mainly just used the FTP method for accessing the EO products. The consortium found that even FTP is complex to use for some users with less technical skills.

The consortium identifies that being able to integrate the EO products data streams directly into the user's IT systems, through for example APIs, would maximise usage and benefit for the users as the process would become more automated and users could combine the EO data with their own internal datasets to run complex analysis on water management issues.

— *Need for ground truthing resources to calibrate EO products*

The overall budget framework did not allow for extensive field campaigns to allow for ground truthing activities to calibrate the EO products to maximise their accuracy. It was hoped IFI and CS organisations would align resources to support this activity. This did occur in Lao and Sahel, but in the case of the latter not to an extent that allows for proper model calibration at national scale. Further resources for ground truthing in Niger are expected in 2019, and hopefully in due time to support calibration for the 2019 crop mapping product. Whilst ground truthing for accurate calibration isn't needed for some of the EO products, such as surface water monitoring, for other others like crop mapping it is an important task to ensure accuracy.

TABLE 2: Example production and delivery status assessment of an EO product for monitoring small reservoirs and dams in the Zambezi

Monitoring of small reservoirs and dams

Rationale	Assessing the amount of small and large-scale water resources in a river basin is essential for efficient planning and decision making for the current and future utilisation potential of the water resources.	**Area of Interest (AoI)**	250,000 km² (Kariba and Tete subbasins, Zimbabwe part)
		Volume	70 MB / month
		Frequency	Monthly for 2 years (2017/2018)
Production summary	The production is on schedule. Projected progress: 13/24 (54%) Actual progress: 13/24 (54%) Fully automatic production and fusion of Sentinel 1 and 2. Manual post-processing and quality verification in place and well tested. Continuous minor adjustments are made to optimise product to local conditions.	**Progress**	13 out of 24 deliverables submitted (54%)
		Issues	Incomplete Sentinel scene archive available through EODC Bug in S1 noise reduction algorithm
		Mitigation (impact)	Manual download of missing scenes (minor extra effort) Bug is currently being addressed; alternative algorithm used (minor extra effort)
User access	Yes, via SFTP and tile server	**Issues & Anomalies**	ZAMWIS database is not designed for high resolution raster visualisation
		Mitigation	Development of new tile server for fast access and easy visualisation of high-resolution raster
Measures of success (cf. REF-14)	1. Users are aware of the capabilities and respective advantages of Sentinel 1 and 2 based water detection.		Yes, training have been provided in EO based water detection procedures with radar and optical imagery
	2. Statistical information addresses stakeholder needs		Yes, statistical outputs in terms of changes in surface water extent and water body counts of interest to users
	3. Product quality		Yes, all monthly water masks achieve an overall accuracy of 85% or more
	4. Product integration		Partly. New tile server allows for rapid visualisation. Drought bulletin still being designed but upon approval it is intended to be published on ZAMCOM website.

— *Short-term outcome 3*
IFI and CS users identify the utility and benefit of the Water Resources Management products

The Service Delivery Utility and Impact Review (D12) assessed the utility and benefits of the Water Resources Management products. For each EO product the key findings were documented in terms of the relevance, effectiveness and sustainability, listing of problems and recommendations for improvements – based on stakeholder feedback – as per Table 3. The consortium included Adelphi,[104] who have monitoring and evaluation skills to support this work and Adelphi appropriately used the OECD DAC Criteria for Evaluating Development Assistance to structure the analysis. IFI and CS user respondents provided the following 'value statements':

> *"The product…impacts are economically valuable to various sectors in this specific case also across two countries, it has a potential to foster cross boundary cooperation. The general product seems to be suitable for a wide range of development projects related to the usage of surface water…."*

> *"Great product to identify both crop intensity and diversification, two of the main metrics resulting from the project"*
>
> — **Prof. Dr. Indira Ekanayake**, Senior Agriculture Economist, World Bank, Myanmar.

> *"Monsoon related flooding is valuable information, as this can benefit intervention planning and assessments greatly with regards to irrigation subprojects."*
>
> — **Indira Ekanayake**, Senior Agriculture Economist, World Bank, Myanmar.

> *"Seasonal information on flood dynamics and patterns are of high importance for planning- and management purposes in Myanmar. Such information is currently not available on a large geographical- and time scale, and that is where EO really adds value.*
>
> —**Prof. Dr. Khin-Ni-Ni Thein**, Lead Hydro-Informatics Centre (HIC), Secretary of Advisory Group (AG) and Member of the National Water Resources Committee (NWRC), Myanmar.

> *"The established web-based portal, addresses a critical knowledge gap and provides an essential platform for ongoing and future projects in Myanmar, where lack of baseline data and reliable climate data are often a serious impediment for the ability to execute meaningful water resource assessments and climate adaptation projects."*
>
> **Indira J Ekanayake**, Senior Agriculture Economist, World Bank

> *"The National Map of Irrigation will help us with difficult management decisions and prioritization of resources to better effectuate water licensing. With this facility, we will now have a better overview of where water abstraction takes place and this information coupled with our water abstraction permits will enable to determine where to focus our efforts on the ground for better management of the water resources in the country"*
>
> —**Peter Banda**, National Water Resource Authority, Malawi.

104 Adelphi. https://www.adelphi.de/en. Accessed January 2019.

TABLE 3: Utility and impact review of an EO product for monitoring of small reservoirs and dams in the Zambezi

Case study (utilisation): ZRBMP.1

Objective	The objective of the product is to establish a baseline dataset (and methodology) for water body mapping for regular (seasonal) monitoring and assessment of surface water resources and storage capacity for planning and management.	**AoI**	250,000 km²
		Frequency	Monthly for 2 years (2018/2019)
Relevance	Water levels and water availability in (privately-held) small dams and reservoirs are largely unmonitored and unaccounted for in the Zambezi River Basin. Lack of knowledge about available water resources of such infrastructures can lead to major inaccuracies in water resources assessments and pose risks to water users dependent on such water resources. Satellite-based monitoring can help to fill existing data gaps and to effectively considering these water resources in planning and decision-making processes (e.g. for assessing hydrological streamflow, irrigation potential or flood risks).		
Effectiveness	This product provides ZAMCOM and Zimbabwe National Water Authority (ZINWA) with a comprehensive overview of surface water bodies and the evolution of their seasonal extents and as such provide the basis for further water related applications and analyses which is the fundamental basis for efficient water resource management.		
Sustainability	As ZAMCOM is a very lean organisation it will be difficult to install this an operational service at ZAMSEC unless more technical staff will be hired. However, promoting this service through ZAMCOM is an opportunity also to demonstrate and stimulate interest in member states for this type of service.		
Problems	ZAMWIS, the local infrastructure at ZAMSEC for disseminating information on the Zambezi basin does not support high resolution raster visualisations. Despite communicating a clear interest in the product there is a lack of uptake in ZINWA which needs to be addressed.		
Recommendations for service/product improvements (short-, mid- and long-term)	New tile server will make the product easily accessible and help facilitate usage and uptake. Finalise, a bulletin to report on the status of surface water resources on a monthly basis (incl. including information on surface water, water levels and rainfall), and to be published via ZAMCOM homepage. Interviewees have uttered the wish to increase ownership in the process of product development. The main recommendation therefore is to increase involvement of ZAMSEC and DWA/ZINWA staff into the actual development and use of the product to ensure ownership of the service product.		

BOX 16: Impact lessons for EO4SD (current) and Space for IDA (future) programmes

Need for multiple mechanisms for users to access EO products

a) **EO4SD:** For remaining un-contracted projects, ensure that the consortium provides the users with a range of methods to access the EO products, including simple FTP servers up to direct integration (e.g. via APIs) into their existing IT systems.

b) **Space for IDA:** For procurement SoWs for 'Activity 1: Knowledge Development', ensure that the consortium provides the users with a range of methods to access the EO products.

Need for ground truthing resources to calibrate EO products

a) **EO4SD:** For remaining un-contracted projects (i.e. Forest Management, Ecosystems Services), include budget for ground truthing and calibration of EO products.

b) **Space for IDA:** For procurement SoWs in 'Activity 1: Knowledge Development', include budget for ground truthing and calibration of EO products.

Water Resource Management
Sustainability

OECD DAC state that 'sustainability' is concerned with measuring whether the benefits of an activity are likely to continue after donor funding has been withdrawn. Projects need to be environmentally as well as financially sustainable.[105]

What activities did the project execute to ensure the benefits of the project continue after donor funding ceased?

The Water Resource Management project has a strong objective to ensure long term adoption of the products to ensure the development impacts of the project continue after the funding ends. The Stakeholder Engagement and Capacity Building Plan (D4) defined the capacity building activities to ensure IFI and CS organisations strengthen their capacity for effective use of EO products in their daily practices of water resources management.

IFI and CS staff do use geo-spatial and EO based information, but this is mostly coarse scale products that are readily available, but not at the spatial and thematic detail available with today's modern sensors. They do not have sufficient capacity to take advantage of the latest EO technology.

To correct this the consortium defined short term and long-term capacity building objectives:

- The **short-term objective** is to update and broaden the knowledge and practical skills of IFI and CS staff in using EO products and applications for integrated management of water resources,
- The **long-term objective** is to integrate EO products in the devising of (inter-) national development projects, management and policy making that are established, guided and continuously validated by science, thereby ensuring the protection, maintenance, and restoration of water resources in the CSs.

— *Capacity Building Courses*

By October 2018 three training events were carried out in Myanmar, Malawi and Bolivia with 64 participants from 13 countries taking part in the trainings. There are a further five training events in the planning stages (Niger twice, Myanmar, Peru and Washington) and two in consideration/pending agreement with the IFIs and CSs (Bolivia and ZAMCOM).

Similar to the Agriculture and Rural Development project, these will be delivered by the ITC Faculty of Geo-Information Science and Earth Observation of the University of Twente – a global leader in training and capacity building in the field of geo-information science, EO and GIS, supported by another member of the consortium depending on core capabilities/ skills. The courses are designed for the two specific primary audiences:

- **IFIs:** Increase the competency of decision makers and IFIs staff in understanding the wider context of different satellite systems and information products/ services to support their operational responsibilities in water resource management and planning,
- **CS:** Hands on experience for stakeholders in CS to support identification, monitoring and evaluation of development projects in their countries.

Capacity building content is also within the Canvas Distance Education portal. The portal has been developed to allow participants to obtain information prior to the start of the workshop, but more important support will continue after the week of 'face to face' interaction. The online portal also features a discussion forum for asking questions, communicating with each other and sharing

105 OECD. 'DAC Criteria for Evaluating Development Assistance'. http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm. Accessed January 2018.

comments, uploading preliminary results of their case study assignments, uploading their results and sharing these with their fellow workshop participants, etc.

— *IT infrastructure and information access*

Slow and unreliable internet access in developing countries is a barrier to adoption of EO products given the heavy datasets involved. The consortium defined the pros and cons of a range of data dissemination mechanisms including the current Sentinel data access mechanisms, the deployment of regional hubs, the use of cloud-computing services as well as direct dissemination and data delivery on media. For each use case for the individual stakeholders there is a need to analyse the data needs and data volumes to design the most optimal data access mechanism.

If the users are just downloading the final EO products from the consortium, IT infrastructure is rarely an issue as the file sizes are manageable. However, if users wish to produce the EO products themselves, from the starting point of downloading data from the Copernicus Open Access Hub (previously Sentinels Scientific Data Hub),[106] then the IT infrastructure for downloading, storing and processing is significant and expensive. Cloud services reduce the need for local IT infrastructure but can lead to high operating costs for cloud storage and processing of large EO datasets. This is another benefit to focusing support on 'EO Regional Expert Centres' that have significant IT infrastructure.

TABLE 4: Data distribution scenarios for EO4SD

Scenario	Pros	Cons
Online archives (e.g. Sentinel data Hub)	Data access infrastructure for general public	Data deployment via internet which may be challenging for users with limited available bandwidth
Cloud computing services (e.g. DIAS)	Potential access to the full Sentinel archive Access to pre-processed data Access to down-stream services Access to software (Brings software to data)	Users may experience less control/ ownership over data and software This option may introduce different payment levels on the users (Platform as a Service)
Regional Hubs (e.g. GMES & Africa)	Data broadcast and reception over communication satellites Internet and bandwidth independent	May be suitable for only certain types of data and products Technology driven mostly suited for technical centres
Data delivery on media (DVD, USB, hard drives etc.)	Independent from any bandwith constraints	Slow It may take days to weeks from data ordering to delivery No mechanism to ensure such a data distribution system beyond GW-A

— *Local offices/local private sector involvement*

Establishing collaboration agreements with local offices and private stakeholders represent an important aspect of the overall project objective for achieving long-term sustainability. In the early stages of 2018, a range of collaboration agreements was established with local offices and private actors in all three focal regions. The consortium has identified that building up local presence will be an important aspect for achieving long-term sustainability. DHI currently has offices in over 30 countries with water management knowledge and networks in their local geography. However, even for an organisation with so many international offices only one implementation country, Peru, was a direct match. Therefore, the consortium has engaged external partners/institutions to provide practical on the ground support in those countries.

Their partners support the consortium to further promote their EO products to local potential customers, acting in a similar manner to a reseller, including activities of: identifying potential client needs, customising EO products to suit clients, identifying additional services for clients, pricing of products, development of marketing and sales models, defining sustainable operating models between the consortium and the local partners. The following

106 Copernicus. 'Welcome to the Copernicus Open Access Hub'. https://scihub.copernicus.eu/. Accessed February 2019.

external partners have been engaged in TROPIS (Senegal), Zambian Institute of Environmental Management (Zambia), Impact Terra and IWMI (Myanmar and Lao) and INCLAM (Peru). The consortium is now engaging with potential clients and visiting client sites in Myanmar, Senegal and soon to be Zambia and Peru.

The consortium identified that the private sector engagement Work Requirement (WR) is important to generate sustainable demand for EO products in the future. However, this WR does draw focus and attention away from the IFIs who the source of future funding for the EO products would be. Therefore, it is important for the consortium to receive adequate recognition of the efforts with the local private sector from ESA.

— *Communication Plan*

The consortium held a series of meetings with IFI and CS stakeholders to inform higher level officials and decision-makers about the benefit of EO products for integrated management of water resources, as well as to exchange knowledge on user requirements. The effectiveness of these was documented in the Communications Effectiveness Review (D6).

Additionally, the consortium used a range of public communication channels to raise awareness, share results and learnings to a broader audience, including:

- flyers summarising each thematic, with supporting product specification sheets,[107]
- ~200 sample map products provided to IFI and CS users,
- a project website,[108]
- EO Demonstrations Overview Map – which includes a user-friendly map interface showing the EO products,[109] to attract user interest,
- online learning portal hosting webinars,[110]
- short introductory video to the project,[111]
- attendance at conferences including,[112] World Water Week, Myanmar World Water Day Celebration, and workshops including ECOWAS regional water observatory and AMCOW Africa Water & Sanitation Sector Monitoring Training Workshop.[113]

— *EO Service Cluster Mainstreaming Roadmap*

A road-map for the long-term use of EO services, both within the IFI working practices and within the CS, will be completed at the end of the project in month 36 (November 2019).

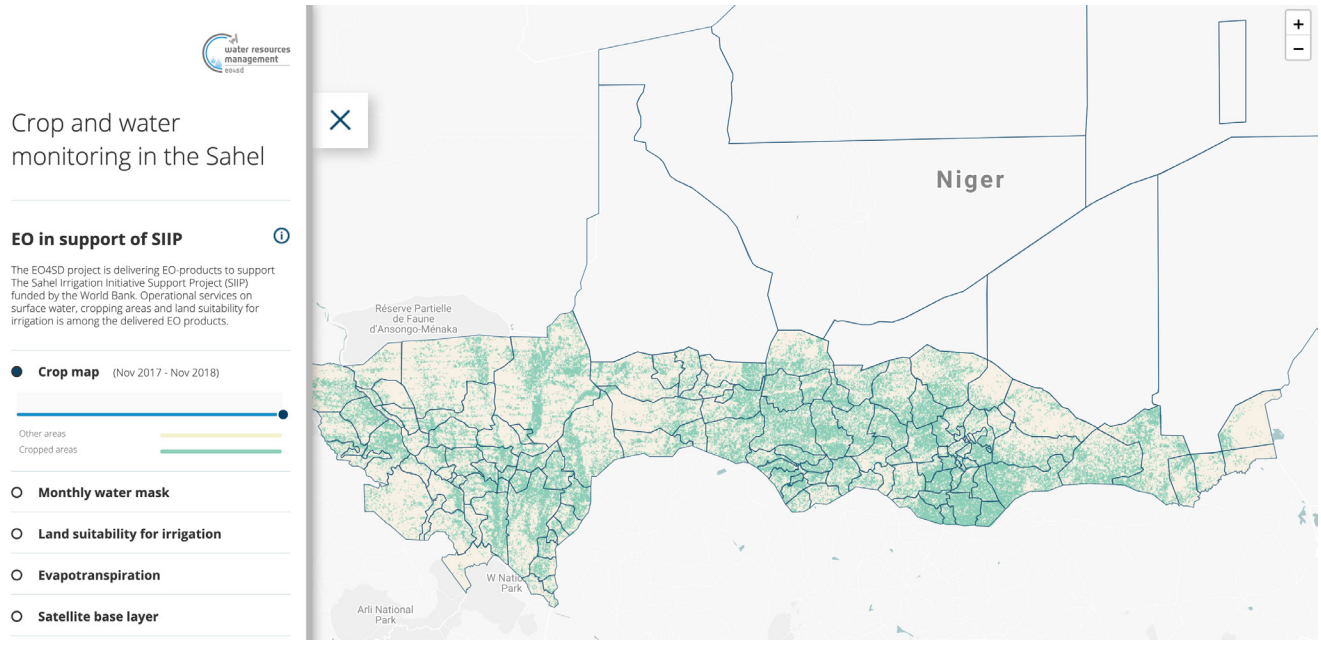

FIGURE 18: Interactive EO data portal on project website

107 ESA. 'water resources management'. http://eo4sd-water.net/portfolio. Accessed December 2018.
108 ESA. 'water resources management'. http://eo4sd-water.net/. Accessed December 2018.
109 ESA. 'EO Demonstrations – Overview map'. http://eo4sd-water.net/content/maps. Accessed December 2018.
110 ESA. 'New online portal learning portal'. http://eo4sd-water.net/news/new-online-learning-portal. Accessed January 2019.
111 ESA. 'World Water Day 2018'. http://eo4sd-water.net/news/world-water-day-2018. Accessed January 2019.
112 ESA Big Data (Toulouse), NEW OPPORTUNITIES IN SATELLITE AND AIRBORNE REMOTE SENSING (Denmark), Land & Poverty Conference (Washington), 2nd Mapping Water Bodies from Space Conference (Frascati), ECOWAS inception workshop on new regional water observatory (TOGO), World Water Week (Stockholm), SDG meeting with national stakeholders in Uganda, Asia Water Forum (Manilla), AARSE conference (Egypt), SIIP launch meeting (Burkina Faso), Ninth GEF Bi-ennial International Waters Conference (Morocco), UNEP meeting on SDG 6.6.1 (Bellagio), ZAMTEC annual meeting (Zimbabwe)
113 ESA. 'water resources management'. http://eo4sd-water.net/news. Accessed January 2019.

To what extent did the benefits of the project continue after donor funding ceased?

There are two specific related outcomes, as assessed as below:

— ***Short-term outcome 4***
IFI and CS users have sufficient budget and capacity to integrate Water Resources Management products into planning, procurement and implementation processes

The Stakeholder Engagement Review (D13) assessed the effectiveness of stakeholder engagement and communications activities with regard to increasing the awareness and acceptance of EO-derived information among relevant stakeholders.

In terms of having sufficient budgets, the IFIs have been variable. WBG has advised that for their Sahel programme they are aligning resources/budget in the 2019 workplan, specifically for EO/remote sensing for their regional monitoring & evaluation systems for the region. The consortium are also in discussion with WBG on how EO could support the Zambezi countries and the transboundary basin programme Cooperation in International Waters in Africa (CIWA) e.g. by using EO for irrigation mapping and surface water monitoring. In Myanmar, WBG are providing a funding pool for data procurement, including EO data. For ADB the consortium is aiming to influence their project scoping documents, by highlighting a role for EO. For IADB the consortium is much earlier in their engagement and their budget availability is less clear.

In terms of having sufficient capacity within the IFIs, WBG is advanced in the use of EO in the water management domain and have published an extensive report on the technologies, potentials and constraints.[114] The next stage would be for WBG to start integrating EO across its water management programmes. ADB have some knowledge in using EO, particularly on Water Productivity, where ADB have developed this capacity through a cooperation with an external research cooperation, instead of internally. For IADB the consortium is much earlier in their engagement and their capacity is less clear.

In terms of having sufficient capacity within the CSs, the consortium has observed high variance in capacity across the continents with higher capability in Latin America, than in Africa. There was also variance in the capacity between countries in a region and between organisations in a country. Therefore, the consortium tailors their capacity building to adapt to these varying existing levels of capability.

— ***Short-term outcome 5***
New business opportunities emerge for the European EO industry

As stated above, external private sector partners have been engaged to conduct business development activities for the consortium in the developing countries, with initial interest in Myanmar, Senegal and soon to be Zambia and Peru. In addition, an IFI has invited proposals from the consortium (outside of EO4SD scope) to support a farmer led irrigation project in Africa, and to support a wetland monitoring project in West Africa.

DHI GRAS have also realised spill over benefits from their EO4SD project into their wider projects, in particular re-using the on the ground experience in these countries and the EO products developed.

What were the major factors which influenced the achievement or non-achievement of sustainability of the project?

— *Positive factors*

Lack of data for reporting progress of UN SDGs: CSs need to report progress against the targets within UN SDG 6: Clean Water & Sanitation, and EO is very suitable for reporting against targets 6.6.1 (Change in the extent of water-related ecosystems over time) and EO also bears some important perspectives for supporting reporting on indicator 6.4.1 (Change in water use efficiency over time) as well as 6.3.2 (Proportion of bodies of water with good ambient water quality). This will therefore be a macro-level driver of demand for EO products within the water management domain.

Advancing space and IT infrastructure: Key ICT trends are driving increased sustainability of EO products including impact of big data, data science, cloud processing, machine learning and the entrance of Google and Amazon into the field.

114 World Bank. 'Earth Observation for Water Resources Management'. http://documents.worldbank.org/curated/en/783571468196447976/pdf/104778-PUB-Box394885B-PUBLIC-pubdate-4-14-16.pdf. Accessed February 2019.

Free EO products for the IFIs versus licensing fees: The provision of the EO products for free to the IFIs is an easier opportunity to raise awareness and increase adoption as the IFIs don't need to source budgets, and IFIs would resist being locked into long term procurement licenses. This does though raise the issue of how and where the private sector would extract future margins from the EO products. DHI GRAS highlighted they believe the more common EO products such as water surface monitoring will be available globally, for free, in the future, e.g. by a UN agency. Therefore, they see the benefit of providing common EO products for free whilst making margins on the more complex EO products that are less commoditised.

DHI parent company: DHI GRAS' parent company DHI is an international software development and engineering consultant firm focused on the water sector, with offices in 30 countries and 1100 employees. The advantage is both the exchange of skills and knowledge between the EO specialism in DHI GRAS and the wider water domain expertise and capacity of DHI. Also, DHI responds to large procurement tenders from CS, IFIs, and NGOs, within which it can identify a role and scope for an EO component for DHI GRAS to deliver. Other SME EO companies typically have less visibility, awareness and credibility in these large scale, non-EO specific tenders.

— *Limiting factors*

Need to focus ESA support on 'EO Regional Expert Centres' in CS: There is a significant gap in the technical expertise and infrastructure between the European EO industry (supply side) and in CS organisation (demand side), for example the national water authorities. The consortium strongly believes the path to success in capacity building is by focusing efforts on 'EO Regional Expert Centres', for complex end-to-end processing and production of EO products, whilst still providing light training to less capable institutions for simply using EO information usage e.g. how to extract relevant statistics and produce visualisations for reporting.

Example centres would include Agrhymet,[115] IGPAC,[116] Centre de Suivi Ecologique (Senegal),[117] Regional Centre for Mapping of Resources for Development[118] (Kenya), as well as some river basin organisations as well as NGOs and trustworthy private partners. These centres of excellence would have the long-term mandate and ambition, and consequently a critical mass of talented staff and technical infrastructure.

Clarity on IFI procurement restrictions: The consortium raised concerns that if they support IFIs on the early design stages of their programme that this would exclude them from being able to tender for the potentially larger subsequent programme implementation work.

Training for IFIs and CSs on the range of mechanisms for IFIs to utilise EO products: The consortiums capacity building is currently focused heavily on training IFIs and CSs to be able to produce EO products themselves. The consortium identifies that they should also be trained on when and how to procure EO products from external expert EO organisations.

115 AGRHYMET REGIONAL CENTRE. http://www.agrhymet.ne/eng/. Accessed August 2019.
116 Ibid.
117 Centre de Suivi Ecologique. https://www.cse.sn/index.php/en/. Accessed February 2019.
118 Regional Centre for Mapping of Resources for Development. https://www.rcmrd.org/. Accessed February 2019.

Focus ESA support on 'EO Regional Expert Centres' in CS

a) **EO4SD:** For remaining un-contracted projects (i.e. Forest Management, Ecosystems Services), increase the focus on the capacity building work packages on 'EO Regional Expert Centres'.

b) **Space for IDA:** In Activity 2: Capacity Building for CS focus efforts on 'EO Regional Expert Centres'. Investigate whether this activity should be merged with Activity 3: Knowledge/Skills Transfer.

Clarity on IFI procurement restrictions

a) **EO4SD:** None.

b) **Space for IDA:** Request IFIs to provide guidance on potential pitfalls whereby consortiums might exclude themselves from later stage implementation programmes, by supporting on earlier programme design stages.

Free EO products for the IFIs versus licensing fees

a) **EO4SD:** None.

b) **Space for IDA:** During design and setup of programme discuss and agree with IFIs and European industry the method of providing EO products to IFIs for either free or with a license fee.

Annex A:
EO4SD Project Portfolios

Annex A: EO4SD Project Portfolios
Urban Development

— *Supporting World Bank:*

- **Advisory Services and Analytics (ASA)**[119] – Is the WBG's nonlending activities – a vital part of how it contributes to development. The consortium supported Dhaka, Karachi and Phnom Penh, to assess how urban spaces are organised in relation to housing areas and informal settlements.
- **Development Economics Research Group (DECDG) Study**[120] – For the city of Kigali to simulate different property values and related tax rates.
- **Urban Planning Study for Tanzania – Impact and Effectiveness of Urban Planning on City Spatial Development**[121] – The consortium supported urban planning in Arusha, Dodoma, and Kigoma (Tanzania).
- **Analytical and Planning Tools for Integrating Multi-Dimensional Data in Urban Slums Program** – The consortium supported analysis of location, size and growth of informal settlements, in Dhaka (Bangladesh) and Lima (Peru).
- **Metro Mumbai Urban Phase-2** (US$970 million)[122] – Programme objective is to improve the suburban rail system of Mumbai Metropolitan area. The consortium provided land-use/land-cover in the metropolitan area for monitoring of the area around the transportation corridors over time.
- **Global Platform for Sustainable Cities (GPSC)**[123] – Programme objective is to provide a forum for knowledge sharing and partnership to achieve urban sustainability. The consortium provided sustainable urban planning in nine cities, namely Bhopal & Vijayawada (India), Melaka (Malaysia), Abidjan (Ivory Coast), Dakar & Saint-Louis (Senegal), Campeche (Mexico) and Lima (Peru).

— *Supporting Asian Development Bank:*

- **Future Cities Program in the Asia and Pacific Region**[124] – Programme objective is to implement ADB's strategic priorities in the urban sector. The consortium provided urban development and planning in Mandalay (Myanmar).
- **Kolkata Environmental Improvement Investment Program Tranche 2** (US$286 million)[125] – Programme objective is to continue improvements in coverage and operational sustainability of Kolkata Municipal Corporation's sewerage, drainage, and water supply services. The consortium provides land use/land cover maps, green area layers and maps of informal settlements for improving current urban planning strategies.
- **Second Integrated Urban Environmental Management in the Tonle Sap Basin Project** (US$1 million)[126] – Programme objective is to support Cambodia in improving urban services and enhancing climate resilience in the Tonle Sap Basin. The consortium provides flood risk assessment analysis and the development of improved urban planning strategies in Stueng Saen, Serei Saophoan, Kampong Chhnang and Pursat.

— *Supporting Inter-American Development Bank:*

- **Emerging and Sustainable Cities Program (ESC)**[127] – Programme objective is to direct support to national and subnational governments in the development and execution of city Action Plans. The consortium provides urban analyses and vulnerability assessment for the cities of Lima (Peru), and Mendoza (Argentina).

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119 World Bank. 'Our Development Knowledge'. http://www.worldbank.org/en/about/annual-report/our-development-knowledge. Accessed February 2019.

120 Daniel Ayalew Ali, Klaus Deininger, Michael Wild. 'Using Satellite Imagery to Revolutionize Creation of Tax Maps and Local Revenue Collection'. http://documents.worldbank.org/curated/en/347231526042692012/pdf/WPS8437.pdf. Accessed January 2019.

121 World Bank. 'Urban Planning Study for Tanzania – Impact and Effectiveness of Urban Planning on City Spatial Development '. https://www.conftool.com/landandpoverty2018/index.php?page=downloadPaper&ismobile=true&filename=02-08-Huang-232_paper.pdf&form_id=232&form_version=final. Accessed February 2019.

122 World Bank. 'Mumbai Urban Transport Project-2A'. http://projects.worldbank.org/P113028/mumbai-urban-transport-project-2a?lang=en. Accessed February 2019.

123 World Bank. 'Global Platform for Sustainable Cities'. http://www.worldbank.org/en/topic/urbandevelopment/brief/global-platform-for-sustainable-cities. Accessed February 2019.

124 Asian Development Bank. 'Regional: Establishing the Future Cities Program in the Asia and Pacific Region'. https://www.adb.org/projects/49053-001/main#project-pds. Accessed February 2019.

125 Asian Development Bank. 'India: Kolkata Environmental Improvement Investment Program – Tranche 2'. https://www.adb.org/projects/42266-025/main#project-pds. Accessed February 2019.

126 Asian Development Bank. 'Cambodia: Second Integrated Urban Environmental Management in the Tonle Sap Basin Project'. https://www.adb.org/projects/50102-001/main#project-pds. Accessed February 2019.

127 IDB. 'What is ESC'. https://www.iadb.org/en/cities. Accessed February 2019.

Annex A: EO4SD Project Portfolios
Agriculture and Rural Development

— *Sahel region*

- Building Resilience through Innovation, Communication and Knowledge Services (BRICKS) (part of Sahel and West Africa Program (SAWAP) (WBG and GEF) (US$14.6 million – all countries)[128] – Programme objective is to improve accessibility of best practices and monitoring information within the Sahel and West Africa program portfolio on sustainable land use and management.[129]

— *Ethiopia*

- Sustainable Land Management Project II (SLMPII, in the Sahel and West Africa Program (SAWAP)) (WBG, IFAD) (US$107 million)[130] – Programme objective is to reduce land degradation and improve land productivity in selected watersheds in targeted regions in Ethiopia.
- Participatory Small-scale Irrigation Development Programme 2 (IFAD) (US$114 million)[131] – Programme objective is to improve income and food security for rural households on a sustainable basis by developing small-scale irrigation schemes and adjacent watersheds.
- Fostering Sustainability and Resilience for Food Security in Sub-Saharan Africa – An Integrated Approach (IAP-PROGRAM) (GEF) (US$805 million – all countries)[132] – Programme objective is to integrate priorities to safeguard and maintain ecosystem services into investments improving smallholder agriculture and food value chains.

— *Morocco*

- Atlas Mountains Rural Development Project (IFAD) (US$61.3 million)[133] – Programme objective is reducing poverty and improving the living conditions of poor rural people through enhanced capacities for income diversification and generation from increased access to markets and sustainable management of natural resources along value chains.
- The Green Morocco Plan (with IFAD)[134] (value unknown) – Programme objective is to support modern agriculture with added value and high productivity (pillar 1) and to improve the living conditions of the small farmer and to fight poverty in rural areas (pillar 2).

— *Burkina Faso*

- Fostering Sustainability and Resilience for Food Security in Sub-Saharan Africa – An Integrated Approach (IAP-PROGRAM) (GEF) (US$805 million – all countries)[135] – Programme objective is to integrate priorities to safeguard and maintain ecosystem services into investments improving smallholder agriculture and food value chains.
- Third Community-Based Rural Development Project (PNGT-2) (Sahel and West Africa Program (SAWAP)) (WBG and GEF) (monetary value unknown)[136] – Programme objective is to expand sustainable land and water management in targeted landscapes and climate vulnerable areas.
- The Forest Investment Program (WBG and AfDB) (monetary value unknown)[137] – Programme objective

128 GEF. 'GGW: Building Resilience Through Innovation, Communication and Knowledge Services (BRICKS) Project'. https://www.thegef.org/project/ggw-building-resilience-through-innovation-communication-and-knowledge-services-bricks. Accessed December 2018.

129 World Bank. 'Project & Operations'. http://projects.worldbank.org/P130888/building-resilence-through-innovation-communication-knowledge-services?lang=en&tab=overview. Accessed December 2018.

130 World Bank. 'Ethiopia; Sustainable Land Management Project Phase II for the year ended July 7, 2017 Audited Project Financial Statement'. http://documents.worldbank.org/curated/en/844611518783261374/Ethiopia-Sustainable-Land-Management-Project-Phase-II-for-the-year-ended-July-7-2017-Audited-Project-Financial-Statement. Accessed December 2018.

131 IFAD. 'Participatory Small-scale Irrigation Development Project II'. https://operations.ifad.org/documents/654016/2782e4ca-079d-48c4-ba67-916cffca79c9. Accessed December 2018.

132 GEF. 'Food-IAP: Fostering Sustainability and Resilience for Food Security in Sub-Saharan Africa – An Integrated Approach (IAP-PROGRAM)'. https://www.thegef.org/project/food-iap-fostering-sustainability-and-resilience-food-security-sub-saharan-africa-integrated. Accessed December 2018.

133 IFAD. 'Agricultural Development: Atlas Mountains Rural Development Project'. https://www.ifad.org/en/web/operations/project/id/2000001403/country/morocco. Accessed December 2018.

134 Maroc.ma. 'Green Morocco Plan'. http://www.maroc.ma/en/content/green-morocco0-plan. Accessed December 2018.

135 GEF. 'Food-IAP: Fostering Sustainability and Resilience for Food Security in Sub-Saharan Africa – An Integrated Approach (IAP-PROGRAM)'. https://www.thegef.org/project/food-iap-fostering-sustainability-and-resilience-food-security-sub-saharan-africa-integrated. Accessed December 2018.

136 TerrAfrica, World Bank, GEF. 'Sahel and West Africa Program in Support of the Great Green Wall Initiative'. https://www.thegef.org/sites/default/files/publications/SAWAP_English_Final_1.pdf. Accessed December 2018.

137 World Bank, African Development Bank. 'Forest Investment Program – Burkina Faso'. https://www.climateinvestmentfunds.org/sites/cif_enc/files/PIF.BURKINA.AIDEMEMOIRE%20-%20EN%20-%208%20mars.pdf. Accessed December 2018.

is to catalyse policies and measures as well as mobilise funds to reduce deforestation and forest degradation and to promote improved sustainable forest management that leads to greenhouse gas (GHG) emission reductions, protection of carbon reservoirs and poverty alleviation.

— *Uganda*

- Project for Restoration of Livelihoods in the Northern Region (PRELNOR) (IFAD) (US$70.9 million)[138] – Programme objective is to increase sustainable production, productivity and climate resilience of smallholder farmers and provide increased and profitable access to domestic and export markets and export markets.
- Vegetable Oil Development Project 2 (VODP2) (IFAD) (US$146 million)[139] – Programme objective is to increase domestic production of vegetable oil and its byproducts, thus raising rural incomes for smallholder producers and ensuring the supply of affordable vegetable oil products to Ugandan consumers.
- National Oil Palm Project (NOPP) (IFAD) (US$210 million)[140] – Programme objective is to support inclusive rural transformation through oil palm investment.

— *Bolivia*

- Rural Land Regularization and Titling Program (IDB) (US$100 million)[141] – Programme objective is to increase legal certainty over rural property.

— *Paraguay*

- Taking Deforestation Out of Commodity Supply Chains (IAP-PROGRAM) (GEF) (US$443 million – all countries)[142] – Programme objective is to reduce the global impacts of agriculture commodities expansion on GHG emissions and biodiversity by meeting the growing demand of palm oil, soy and beef through supply that do not lead to deforestation.

— *Cambodia*

- Tonle Sap Poverty Reduction and Smallholder Development Project (ADB & IFAD) (US$500 million)[143] – Programme objective is reduction of rural poverty, improvement in the socio-economic condition, and enhance quality of life of the poor by enhancing the productivity and income growth of rural households and supporting diversification of agriculture through improved access to technology and markets in the three Tonle Sap provinces.
- Climate Resilient Rice Commercialization Sector Development Program (ADB) (US$79 million)[144] – Programme objective is to support and accelerate the efficient and effective implementation of the Strategy on Agriculture and Water (SAW) and the Policy on the Promotion of Paddy Production and Rice Export (the Rice Policy).
- Strengthening Coordination for Management of Disasters Project (ADB) (US$2 million)[145] – Programme objective is improved policy and institutional capacity for disaster management in Cambodia.

— *Syria*

- World Bank Report 'The Toll of War: The Economic and Social Consequences of the Conflict in Syria' (WBG) (monetary value unknown)[146] – This study assesses the economic and social consequences of the Syrian conflict as of early 2017.

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138 IFAD. 'Project for the Restoration of Livelihoods in the Northern Region'. https://www.ifad.org/en/web/operations/project/id/1681/country/uganda. Accessed December 2018.

139 IFAD. 'Vegetable Oil Development Project 2'. https://www.ifad.org/en/web/operations/project/id/1468/country/uganda. Accessed December 2018.

140 IFAD. 'National Oil Palm Project (NOPP)'. https://www.ifad.org/en/web/operations/project/id/2000001484/country/uganda. Accessed December 2018.

141 IDB. 'BO-L1113 : Rural Land Regularization and Titling Program'. https://www.iadb.org/en/project/BO-L1113. Accessed November 2018.

142 GEF. 'Taking Deforestation Out of Commodity Supply Chains (IAP-PROGRAM)'. https://www.thegef.org/project/comm-iap-taking-deforestation-out-commodity-supply-chains-iap-program. Accessed November 2018.

143 ADB. 'Cambodia: Tonle Sap Poverty Reduction and Smallholder Development Project'. https://www.adb.org/projects/41435-022/main#project-pds. Accessed December 2018.

144 ADB. 'Cambodia: Climate Resilient Rice Commercialization Sector Development Program'. https://www.adb.org/projects/44321-013/main#project-overview. Accessed December 2018.

145 ADB. 'Cambodia: Strengthening Coordination for Management of Disasters'. https://www.adb.org/projects/46230-001/main. Accessed December 2018.

146 World Bank. 'The Toll of War: The Economic and Social Consequences of the Conflict in Syria'. https://www.worldbank.org/en/country/syria/publication/the-toll-of-war-the-economic-and-social-consequences-of-the-conflict-in-syria. Accessed December 2018.

Annex A: EO4SD Project Portfolios
Water Resources Management

— *Supporting World Bank*

- Zambezi River Basin Management Project (WBG) (US$4 million)[147] – Programme objective is to strengthen Zambezi Water Course Commission (ZAMCOMs) role in promoting cooperative management and development within the Zambezi River Basin.
- Sahel Irrigation Initiative Support Project (WBG) (US$197 million)[148] – Programme objective is to improve stakeholders' capacity to develop and manage irrigation and to increase irrigated areas using a regional 'solutions' approach in participating countries across the Sahel.
- Horn of Africa – Groundwater Initiative (WBG) (US$2.5 million)[149] – Programme objective is to strengthen the knowledge and analytical foundation for cooperative management and development of international waters in Sub-Saharan Africa to aid sustainable climate resilient growth.[150]
- Ayeyarwady Integrated River Basin Management Project in Myanmar (WBG) (US$100 million)[151] – Programme objective is a strengthened, integrated, climate resilient management and development of the Ayeyarwady River Basin and national water resources.
- Integrated Water Resources Management in the Titicaca-Desaguadero-Poopo-Salar de Coipasa (TDPS) System (WBG and GEF) (US$47.4 million) – Programme objective is to promote the conservation and sustainable use of water resources in the Titicaca – Desaguadero – Poopó – Salar de Coipasa (TDPS) transboundary system, through the updating the Global Binational Master Plan.
- Agricultural Development Support Project (WBG) (US$100 million)[152] – Programme objective is to increase crop yields and cropping intensity in selected existing irrigation sites in the Bago East, Nay Pyi Taw, Mandalay, and Sagaing regions.
- Integrated Water Resources Management in Ten Basins (WBG) (US$88.2 million)[153] – Programme objective is to strengthen the capacity of targeted water resources management related institutions to plan, monitor and manage water resources at the national level and in selected river basins in Peru.

— *Supporting Asian Development Bank*

- Lao People's Democratic Republic: Sustainable Rural Infrastructure and Watershed Facility (ADB) (US$2.7 million)[154] – Programme objective is to address issues of PRI and watershed management in mountainous provinces of Northern Lao PDR by using an integrated land use planning approach that integrates efficient, sustainable and climate resilient rural infrastructure, and feasible watershed protection measures.
- Myanmar: Irrigated Agriculture Inclusive Development Project (ADB) (US$106 million)[155] – Programme objective is to strengthen agriculture production and value chain development by improving and modernising irrigation systems in three regions of the country's central dry zone.

— *Supporting Inter-American Development Bank*

- National Irrigation Program with a Watershed Approach III (PRONAREC III) (IADB) (US$196 million)[156] – Programme objective is to boost the productivity of small-scale farmers by increasing the land area under irrigation; enhance the efficiency of water use in irrigation systems; and improve the management of water resources for irrigation purposes.

147 World Bank. 'Zambezi River Basin Management Project'. http://projects.worldbank.org/P143546?lang=en. Accessed January 2019.
148 World Bank. 'Sahel Irrigation Initiative Support Project'. http://projects.worldbank.org/P154482?lang=en. Accessed January 2019.
149 World Bank. 'Horn of Africa – Groundwater Initiative'. http://projects.worldbank.org/P169078?lang=en. Accessed January 2019.
150 World Bank. 'Project Information Document/Identification/Concept Stage (PID)'. http://documents.worldbank.org/curated/en/259271539954342284/pdf/Project-Information-Document-PID-Horn-of-Africa-Groundwater-Initiative-P169078.pdf. Accessed January 2019.
151 World Bank. 'Ayeyarwady Integrated River Basin Management Project'. http://projects.worldbank.org/P146482?lang=en. Accessed January 2019.
152 World Bank. 'Agricultural Development Support Project'. http://projects.worldbank.org/P147629?lang=en. Accessed January 2019.
153 World Bank. 'Integrated Water Resources Management in Ten Basins'. http://projects.worldbank.org/P151851?lang=en. Accessed January 2019.
154 Asian Development Bank. 'Lao People's Democratic Republic: Sustainable Rural Infrastructure and Watershed Facility'. https://www.adb.org/projects/50236-001/main. Accessed January 2019.
155 Asian Development Bank. 'Myanmar: Irrigated Agriculture Inclusive Development Project'. https://www.adb.org/projects/47152-002/main#project-pds. Accessed January 2019.
156 Asian Development Bank. 'PRONAREC Bolivia: National Irrigation Program with a Watershed Approach'. https://publications.iadb.org/en/pronarec-bolivia-national-irrigation-program-watershed-approach. Accessed January 2019.

Annex B: Glossary

ADB: Asian Development Bank

CBA: Cost-benefit analysis is a 'value-for-money' analysis. It compares completed or potential courses of actions, or to estimate (or evaluate) the value against the cost of a decision, project, or policy.[1]

CEA: Cost-effectiveness analysis is a 'value-for-money' analysis. It compares the relative cost of achieving the same impact using alternative approaches and can be used to assess whether one solution provides the least costly method to achieve desired results.

Client States (CS): This refers to the recipients of development financing. For the main IFIs, these recipients are mostly the governments of the developing country. Note that the main IFIs use their own (differing) terms to identify these recipients.

Copernicus: The European Union's Earth Observation Programme, looking at our planet and its environment for the ultimate benefit of all European citizens. It offers information services based on satellite Earth Observation and in situ (non-space) data.[2]

Development Aid community: Those stakeholders involved in the provision of Development Aid, including IFIs, National Development Aid Agencies and Private Foundations.

Earth Observation (EO): The gathering of information about the physical, chemical, and biological systems of the planet via remote-sensing technologies, supplemented by Earth-surveying techniques, which encompasses the collection, analysis, and presentation of data.[3]

EIA: Environmental Impact Assessment

EO Information Service Sector: This refers to companies and/or organisations that are producing EO-based information products and services and delivering these to users (either public or private sector).

EO4SD: ESA programme to start the integration of satellite information products & services, as 'best-practice' environmental information, in the planning and implementation of the development projects, programmes and activities.

ESA: European Space Agency

GEF: Global Environment Facility

IADB: Inter-American Development Bank

International Financial Institutions (IFIs): Refers to the institutions created by a group of countries that provide financing and professional advising for the purpose of development. Examples include World Bank Group, Asian Development Bank and International Fund for Agricultural Development.

IFAD: International Fund for Agricultural Development

Monitoring & Evaluation (M&E): Is an objective process of understanding how a project was implemented, what effects it had, for whom, how and why. [4]

MOI: Memorandum of Intent

1 Wikipedia. 'Cost-benefit analysis. https://en.wikipedia.org/wiki/Cost%E2%80%93benefit_analysis. Accessed January 2019.

2 Copernicus. 'What is Copernicus'. https://www.copernicus.eu/en. Accessed January 2019.

3 Wikipedia. 'Earth Observation'. https://en.wikipedia.org/wiki/Earth_observation. Accessed January 2019.

4 Caribou Digital.

National Development Aid Agency: Which provide regional and international development aid and are the government departments responsible for administering ODA, for example UK DFID, German GIZ and France AFD.

ODA: Official Development Assistance is a term defined by the Development Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development (OECD) to measure aid.[5]

OECD: The Organisation for Economic Co-operation and Development is an intergovernmental economic organisation with 37-member countries, founded in 1961 to stimulate economic progress and world trade.[6]

SOW: Statement of Work

UN SDGs: United Nations Sustainable Development Goals

Sentinel: ESA's Sentinel satellites are for the operational needs of the Copernicus programme. Each Sentinel mission is based on a constellation of two satellites to fulfil revisit and coverage requirements, providing robust datasets for Copernicus Services.[7]

Stakeholders: This refers to the body of users closely involved in the planning and implementation of international development activities.

Space for IDA: Space for International Development Assistance – a potential ESA programme from 2020–2025.[8]

UAV: An Unmanned Aerial Vehicle, commonly known as a drone, is an aircraft without a human pilot aboard.[9]

WBG: World Bank Group

WBS: Work Breakdown Structure

WR: Work Requirements

5 Wikipedia. 'Official development assistance'. https://en.wikipedia.org/wiki/Official_development_assistance. Accessed January 2019.

6 Wikipedia. 'OECD'. https://en.wikipedia.org/wiki/OECD. Accessed January 2019.

7 ESA. 'Overview'. https://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Overview4. Accessed September 2019.

8 Caribou Space and ESA. 'Satellite environmental information and Development Aid : An Analysis of Longer-Term Prospects'. https://e04society.esa.int/event/european-consultation-meeting-on-expanding-the-use-of-satellite-based-information-in-development-aid-activities/. Accessed November 2018.

9 Wikipedia. 'Unmanned aerial vehicle'. https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle. Accessed January 2019.

Caribou Space supports organisations to bridge the space and development worlds. We work with governments, space agencies, development agencies and private sector space companies.

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