Cost-Effectiveness Analysis of the CommonSensing Project

Interim Report

May 2020

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This interim report is a product of the Planning, Performance Monitoring and Evaluation Unit of UNITAR. The findings and conclusions expressed therein do not necessarily reflect the opinion of the partners and countries of the CommonSensing project or its donor. The analysis was conducted by Ms Gemma Piñol Puig, Independent Evaluator. The report is issued without formal copy editing. A final CEA Report will be issued in conjunction with the end-line evaluation of the CommonSensing project.

Table of Contents

Abbreviations

CE	Cost-effectiveness
CEA	Cost-Effectiveness Analysis
EO	Earth Observation
IPP	International Partnership Programme
M&E	Monitoring & Evaluation
OECD-DAC	Organization for Economic Cooperation and Development – Development Assistance Committee
SDG	Sustainable Development Goal
SIDS	Small Developing States
UAV	Unmanned Aerial Vehicle
UKSA	United Kingdom Space Agency
UN	United Nations
WB	World Bank

Executive Summary

This interim report presents the findings of the initial cost-effectiveness analysis (CEA) of CommonSensing, a project financed by the International Partnership Programme (IPP) of the United Kingdom Space Agency (UKSA). The findings form part of the project's mid-line evaluation and contribute to the assessment of the 'efficiency' criterion. The CEA will be reviewed at the end of the project in conjunction with the end-line evaluation. Hence, this document presents the interim results of the CEA relative to non-space alternatives.

The CommonSensing project aims to increase access and capacity to manage Earth Observation (EO) data and information that can support enhanced decision making of small island developing states (SIDS) to adapt to climate change. The project is implemented in three Pacific countries: Fiji, the Solomon Islands and Vanuatu. The project started in March 2018 (with a one-year inception phase) and is scheduled to end in March 2021. The project included many intended results, from capacity development to an increase of climate funding. For the present CEA, the following expected result and indicator areused: Result 10. By 2030, enhanced DRR and climate change resilience in Fiji, the Solomon Islands and Vanuatu in support of SDG 13 (Climate action) and SDG 9 (Industry, innovation and infrastructure)' measured by indicator: '10.3.1: Amount of climate-related finance available from all sources'.

The two non-space-based solutions chosen for comparison are Alternative 1, the unmanned aerial vehicle (UAV) and Alternative 2, aircraft imagery, since it was determined that these two data collection methods can deliver approximately similar impacts as the space-based solution. The CEA finds that the space-based solution as provided by CommonSensing would prove to be cost-effective, with a ratio of 0.087, compared to the UAV and aircraft method, with ratios of 0.338 and 0.141, respectively. This finding is confirmed for the duration of the project from 2018 to 2020, as well as beyond (from 2021 to 2023).

The main risks and limitations encountered by the present analysis include the following:

- The CommonSensing project uses UAV non-space-based solutions for research purposes and data gaps. These costs have not been deducted from the CEA. The analysis is therefore an imperfect comparison between space- and non-space-based solutions.
- Monitoring and evaluation (M&E) costs have not been fully deducted, as some costs related to project monitoring and self-evaluation were embedded in the budget's project management component. Only independent evaluation costs have been deducted from the CEA as these costs would not be incurred in a commercial setting.
- The costs of alternatives are estimated. Underbudgeting is likely since it was not possible to cross-check and validate these costs as the field work was cancelled because of the COVID-19 crisis.
- While CommonSensing is a multi-country project, the same solutions are not provided to all three countries. Only Fiji will have access to data cube technology, for example. The CEA is based on the whole project since there was no cost breakdown by country in the project budget.
- During the project implementation period, the project countries experienced two main emergencies: Cyclone Harold and COVID-19. At the time of this report, the impact from these two events on the project was not yet known.

The report's primary audience is the CommonSensing project consortium, beneficiary countries, the UKSA and Caribou Space. Secondary audiences include other International Partnership

Programme grant recipients, and research organizations in the fields of disaster mitigation, EO and CEA.

1.Introduction

1. The small island developing States (SIDS) in the Pacific Ocean are among the most vulnerable countries in the world to climate change and natural disasters. Vanuatu is the world's second most vulnerable country, and Solomon Islands ranks in seventh position. Besides being prone to cyclones, most Pacific SIDS are situated on the Ring of Fire, which implies high exposure to earthquakes, volcanic eruptions, and tsunamis. Climate change exacerbates natural disasters and increases vulnerability due to rising sea levels, extreme weather conditions, deteriorating soil quality and coral bleaching, among other effects. The institutional and financial capacities of SIDS to cope with natural disasters and the effects of climate change are limited. Most SIDS are least developed, low income countries, and their economies are highly sensitive to natural disasters and other shocks. Governments lack institutional frameworks sufficiently sophisticated to develop adaptative strategies, experience shortages of human resources while they must address the pressing social and economic challenges of any developing country. It has also been acknowledged that adapting to climate change and variability is extremely costly and, thus, unaffordable for small economies.

2. Within this context, many financial mechanisms, including climate finance funds, have been created to support low income countries to strengthen resilience and adapt to climate hazards. However, the complexity of the matter combined with the requirements to fulfill present significant challenges for the Pacific SIDs to access climate funds. In most of these countries, data is unavailable, information is of poor quality and technical expertise is limited to create, manage, and interpret data and information and, in turn, plan appropriately.

3. The CommonSensing project responds to these challenges by addressing both capacity needs and data gaps. Concretely, the overall objective of the project is to enhance disaster risk reduction and climate change resilience in Fiji, the Solomon Islands and Vanuatu through two specific objectives:

   - **Objective 1:** To increase national resource capacities in the use of Earth Observation (EO) solutions to address disaster risk reduction and climate change resilience in Fiji, the Solomon Islands and Vanuatu by 2020; and
   - **Objective 2:** To enhance evidence-based decision making by using CommonSensing solutions for disaster risk reduction and climate change adaptation by the end of 2020.

4. The underlying assumption of the project is that by strengthening capacities of partner countries in the Pacific to collect, analyse and interpret data along with access to information and data provided by satellite-based solutions, they will be able to capture more financial resources to adapt to climate change and enhance their resilience. The CommonSensing project contributes to Sustainable Development Goal (SDG) 9 (Industry, Innovation, and Infrastructures) and SDG 13 (Climate Action). The project is funded through the International Partnership Programme (IPP) of the United Kingdom Space Agency (UKSA) and implemented by a consortium of project partners composed of the UNITAR (UNOSAT), the Satellite Applications Catapult, University of Portsmouth, Devex, Sensonomic, UK Meteorological Office, Commonwealth Secretariat with the governments

of partner countries (Fiji, Solomon Islands and Vanuatu), and Radiant Earth (which disengaged from the project at the end of 2019).

5. The method developed by the CommonSensing project will process optical imagery from Sentinel-2, SPOT and Landsat, radar imagery from S-1 and elevation data from PARSAR to create data layers for nearshore bathymetry, coastal terrain and geohazard zones, as well as layers for coastal land cover to obtain maps of physical risk. However, the data provided by satellite instruments need to go through a series of complex pre-processing steps to turn the raw data into information that can be analysed and used. Therefore, the project entails setting up a system that will provide cross-sectoral data that is ready for exploitation by non-specialists, allowing partner governments to use interpretations with little capacity to manage these data. This will be achieved through Analysis Ready Data (ARD) and data cube technology and hosted by a platform. This platform will include the CommonSensing Spatial Decision Support System (CSSDS) and CommonSensing web portal, and users will be able to interact with it through mobile applications created for this purpose, such as the geoRiskCheck app. These deliverables are supported by capacity development activities, including training, awareness-raising events, and backstopping support on demand.

6. The project's M&E framework calls for a baseline, mid-line and end-line evaluation, as well as a draft cost-effectiveness analysis (CEA) at mid-term which will be finalized at the end of the project. There has been increasing interest among the international community on the effectiveness and impact of aid. Many methodologies have been developed to assess quality and costs in relation to project outcomes, such as value-for-money, CEA, etc. The CEA is characterized by its focus on measuring the cost per unit of impact, or in other words, the cost of achieving one unit of outcome. This type of analysis enables the comparison of projects with a common or similar impact and provides input to assess the project's efficiency criterion, in accordance with the Organization for Economic Cooperation and Development – Development Assistance Committee's (OECD-DAC) criteria.

7. The present CEA assesses the cost-effectiveness of the space-based method used in the project. The assumption is that the space-based method proposed by the CommonSensing project is more cost-effective than any other non-space-based method available on the market. To prove this assumption, two non-space alternative solutions that can deliver similar results (i.e. the same or similar volumes of data) and that are available on the market have been considered: Alternative 1, the unmanned aerial vehicle (UAV) method, and Alternative 2, aircraft imagery (helicopter). These two alternative solutions have been chosen, as they are the methods available that can deliver data and information comparable to that provided by satellite in terms of precision, time, and costs. A third non-space-based alternative could be terrestrial surveying, but this method was discarded for comparison because it could not ensure the levels of precision, timeframe, and coverage of the other two alternatives. The CEA is performed for the implementation period of the project (2018–2021) plus three years to measure the legacy and sustainability of results.[1]

8. The present report elaborates on the process to deliver the present CEA as well as an analysis of the results. It provides detailed information on the assumptions, methodological considerations, risks, and steps taken to deliver the CEA. By the end of the document, the CEA results will be analyzed, including testing the main hypothesis of the present CEA. The main audience of the present project is the institutional partner and main funder of

[1] 2021 is included as one of the three years since the project is scheduled to be completed before the end of the first quarter.

the project, UKSA, the project consortium and organizations responsible for the M&E of IPP (Caribou Digital and London Economics) which are also responsible for the development of the methodology and validation of the CEA. Secondary audiences include public officials from partner countries, local civil society organizations, development agencies providing climate finance in targeted countries, the University of South Pacific and the South Pacific Community[2]. Researchers and practitioners in the field of EO and/or climate change, academia, international non-profit organizations, and other UN agencies may also be interested in the CEA report.

2. Methodology

2.1. Definition

Time horizons of the CEA

9. The CommonSensing project was launched in March 2018 and it is expected to end by March 2021. For the CEA, a two-year period of consolidation and operation is modelled until April 2023. The time horizon 2018–2021 represents the costs involved and results obtained during the implementation period (including a one-year inception phase). The additional period should reflect the costs of maintaining the services established by the project (i.e. the cost of ensuring the sustainability of the project's results). Therefore, the CEA comprises a period of six years and all the costs and benefits corresponding to this period are considered in this CEA.

Scope of the project: CommonSensing Project

10. The overall objective of the CommonSensing project is to improve national resilience to climate change, including disaster risk reduction, and contribute to sustainable development in Fiji, the Solomon Islands and Vanuatu using remote sensing. The specific objective of the project is to integrate EO-derived services and develop the capacities of governments in partner countries to use them. The overall expected impact of the project is aligned with the 2030 Agenda: 'By 2030, enhanced DRR and climate change resilience in Fiji, Solomon Islands and Vanuatu in support of SDG 13 (Climate Action) and SDG 9 (Industry, Innovation and Infrastructure)'. This overall result is disaggregated in different indicators, including project logframe indicator 10.3.1: Amount of climate finance available from all sources, which the CEA uses as the basis for measuring the project's impact.

11. The intervention logic is based on the concept that the development of capacities using remote sensing with increased access to observation services will help partner countries to increase their capacity and chances to capture climate-related finances and, in turn, their capacity to enhance their resilience and cope with climate change. Remotely sensed satellite imagery provides a non-invasive method for monitoring the Earth's physical, chemical, and biological systems. The solution seeks to enable users to have access to and use EO data in a format and structure that is ready for exploitation to design policies and projects related to food security, climate change and disaster risk reduction in a more efficient manner. The project consists of creating a data service with cross-sectoral information related to disaster risk planning, food security, climate risk and other environmental concerns. Among the main deliverables, there are the CommonSensing Spatial Decision Support System, CommonSensing Web portal and two apps: the geoRiskCheck app and surveyPRISM app. The project combines remote sensing with

[2] Inter-institutional organization that has been providing a similar service to Pacific Island Country governments for many years.

both global and local datasets as part of a complex data fusion system to handle the big data challenges in EO. The solution proposed by the present project is not a 100 per cent space-based solution, however. The crowd-sourced data is gathered using a mobile phone app, and the decision support system is very much based on socio-economic data gathered through apps. Furthermore, at the end of 2019, one of the project partners (Radiant Earth) left the project, which led to the modification of activities and a budget reallocation. Changes included activities related to drone surveying to supplement the data on building types and neighborhoods and to assist machine learning researchers in improving the detection and classification of ‘urban texture’ types using satellite imagery of the CS project, which is limited to 10m x 10m pixels. The project will also employ drones to deliver training about disaster risk management, as this was requested by participants during workshops delivered during the implementation of the project. Thus, the sole purpose of adding drone-based activities was intended to address a data gap problem with the satellite remote sensing of urban texture.

12. The CEA costs for the project’s solution include the identification of the project, operational services, data, software, data cube technology to store large data volumes, drone-based activities, local and international travel, and training expenses. The CEA is based on the costs of a five-year project and, therefore, the impacts of inflation are discounted for comparison at 2018 prices. While completing the CEA template, the following assumptions were made:

    a) The project runs from March 2018 to March 2021 (to simply calculations, three calendar years from January to December are used instead March 2018 to March 2021).
    b) At the time of the present CEA, the project was still being implemented (beginning of 2020). Costs allocated to 2018 and 2019 correspond to actual expenses, which totaled 55.17 per cent of the total budget. In the absence of budget breakdown per year, the same level of expenditure has been assumed for 2018 and 2019.
    c) For the remaining 44.83 per cent of the budget, it has been assumed that remaining will be expended during the last year of the project.
    d) The two in-kind contributions have been equally divided into three project years: The in-kind contribution − 1) Data from the US State Department and 2) Contributions from country partners in terms of labour − has been equally allocated to each year after deducting 20 per cent for management costs (e.g. (7.500.000-1500000 (20 per cent)/3=2.000.000 GBP)[3] and responds to specific requirements set by the IPP and that would not be incurred by a market based project.
    e) The additional two years at the end of the project are considered an extension of the project. These costs will coincide with the costs of the final year. The guidelines propose the costs of these additional years should be the same as the last year of project implementation to reflect the operational costs to end users for using the solution in post-grant period.
    f) All prices are based on 2018 prices in GBP since the project started in 2018, not in 2017.

[3] Management costs are excluded from the analysis because they would not be incurred in a commercial setting.

Alternative 1: Unmanned aerial vehicle - drone-based solution

13. Alternative 1 employs UAVs (i.e. drones) on a rolling basis to cover all three countries and would involve the use of field staff. The drone-based solution was calculated based on the costs of a World Bank (WB) project[4] carried out in Fiji, Vanuatu and Tonga that consisted of using drones to survey the damages from cyclones Palm (2015 in Vanuatu), Winston (2016 in Fiji) and Gita (2018 in Tonga)[5] combined with information from similar studies[6]. While costs were only available for Tonga, the methodology was the same. These costs included two data collection processes, one before the disaster and the other afterwards.

14. The UAV collected images of urban, cropland and shoreline areas. In one two-hour flight, the UAV of this project covered an area of around 12 km2 and apparently provided more detailed images than those provided by satellite (IBRD et al., 2019). Since the budget information obtained was aggregated, most of the costs for Alternative 1 had to be calculated. The total cost of the project was $500,000 (2018 prices as the project took place in 2018), with 18 per cent of the budget devoted to training and 10 per cent of the total budget covering managerial costs. However, the costs of equipment and operating UAV systems had to be calculated. The operating costs were calculated based on the costs of operating the UAV system per square kilometer. In the case of Tonga, the project covered 260 km^2. The cost of the equipment for the alternative was estimated based on another study that compares the cost of using UAV with the costs of using satellite systems. This equipment was considered much more appropriate for comparison. When completing the costs for CEA analysis purposes, the following is assumed:

    a) The UAV project devoted 18 per cent of the total budget to training. Therefore, it is assumed that the training costs of the present alternative also represent 18 per cent of the total budget of the alternative. Training is included under other costs.
    b) It is assumed that the project would receive the same in-kind contribution from the US State Department as the CommonSensing project. In-kind contributions from partner countries are not included, as the WB project did not consider them.
    c) It was also assumed that the type of UAV system would be the one used in the reference project, a Goshawk III by V-TOL able to capture up to 40 km^2 per day, since this fixed-wing drone type is preferred for larger areas, but can also be used for surveying small areas and damage assessment purposes. For larger areas and surveying purposes, the case study as well as other studies suggested to use a similar type of UAV but with better performance. Therefore, it is assumed that Alternative 1 would use a fixed-wing UAV, concretely UAV Factory Penguin B, because it offers more hours of flight (which reduces the costs of landing and takeoff) and has a range of 36Km^2 with resistance to high winds typical in the Pacific islands. These types of UAVs are normally used for land surveying for agriculture and environmental purposes and can capture infrastructures. Other characteristics considered are: 1) its capacity to provide better control of flight parameters, 2) better control of imaginary quality and 3) recovery from power loss (IBRD et al., 2019; Jeziorska, 2019).
    d) In line with the characteristics of the UAV platform and the capacity needed to map large areas, it is assumed that a high-resolution camera with a large sensor would be needed, similar to a Canon EOS 5D Mark IV 36x24 mm (full frame), resolution 30, 890 weight, as suggested in the study.

[4] Technical Guidelines for Small Island Mapping with UAVs' (IBRD et al., 2019).
[5] In Tonga, was not only for cyclone damage, since a first flight surveying the area took place before the cyclone. The equipment budgeted is more sophisticated than what was used for assessing damage and often for surveying larger areas.
[6] IBRD et al., 2019; Jeziorska, 2019.

e) The software chosen is among those proposed by the reference study as well as the number of people to manage the UAV, a team of three people.
f) Finally, the same levels of expenditure for CommonSensing: 55.17 per cent of expenditures during the first two years and 44.83 per cent in the last two years.
g) The exchange rate US$/GBP used to calculate the costs was the average exchange rate of 2018: 1US$ = 0.75 GPB[7]

15. Despite many studies reporting that drones are most cost-effective for small-scale projects, their endurance and capabilities are increasing rapidly, leading one to believe that they could also provide cost effective for medium to large-scale projects. In recent years, the use of drones has become quite affordable, including the costs of training and licensing. The costs of acquisition, storage, fueling and maintaining are becoming less expensive hence drones are emerging as a competitor to the EO and aerial mapping solutions. Drones can fly in poor weather conditions, provide high-resolution imagery at unprecedented oblique angles, and create 3D models, mainly of infrastructures. This type of view was only possible with helicopters at a much more expensive cost.

Alternative 2: Aircraft imagery (by helicopter)

16. The second alternative case is aerial imagery with helicopters. Video footage is collected and processed on rolling bases to cover the three countries. The budget items were defined based on the information found in a desk review of different CEA analysis that compares satellite imagery, drone-based imagery and aerial imagery by plane/helicopter and information collected from the field. The costs include a team for data collection, pilot and technician for the helicopter, helicopter rental and contractual use, fuel, and equipment for the data collection (e.g. video and photo processing, GIS processing, software etc.). The study was also used to calculate the quantity of hours to cover the three countries. There, 530Km2 were surveyed in 64 hours. The helicopter-based solution was calculated based on the costs of renting a helicopter in Vanuatu[8] as well as labour costs (e.g. piloting), local travel costs, per diems and fuel in this country in 2018. The costs of the equipment were also estimated based on the same study. Therefore, the following assumptions were made to develop the budget of Alternative 2:

a) The quantity of hours needed to survey each targeted country was calculated based on the assumption that 64 hours are needed to cover 530 km^2. On this basis, the total number of hours for all three countries was calculated.
b) Management costs, international travel costs, subcontracts, in-kind contributions in the form of data requirements and labour are assumed as the same as for CommonSensing.
c) In-kind contributions from the US State Department in the form of data and in-kind contributions in the form of labour from partner countries will be the same as for the CommonSensing project.
d) For comparison purposes, the costs include two data collection processes. As in both previous alternatives, two or more data collection processes are included in the budgets. Therefore, the costs of data collection (with the exception of a workstation) and local travel are doubled.
e) It is assumed that the project will use the same software as in Alternative 1.

[7] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/768556/average-year-to-december-2018.csv/preview (last visited (1/05/20)
[8] Costs of renting a helicopter in Fiji are to be checked.

f) Finally, the same level of expenditure is assumed as for the CommonSensing project: 55.17 per cent during the first two years and 44.83 per cent in the last two years.
g) The exchange rate US$/GBP used to calculate the costs was the average exchange rate of 2018: 1US$ = 0.75 GPB[9].

17. The closest alternative to satellite imagery is the use of helicopters since these are considered as the most appropriate solution for large projects, like CommonSensing. Although imagery solution by helicopters was resource intensive in the past, costs have decreasing considerably due to the integration of new technologies and the reduction in other costs (e.g. fuel)[10]. The advantage of helicopters is that sometimes they can provide higher-resolution imagery than a satellite and cover much larger areas than drones.

18. Finally, it is important to highlight that drawing direct comparisons between these three technologies is inherently difficult because the most cost-effective solution depends very much on the project requirements, sector, and business model. This becomes even more difficult when dealing with alternatives that are commercially sensitive with drastic changes in their costs.

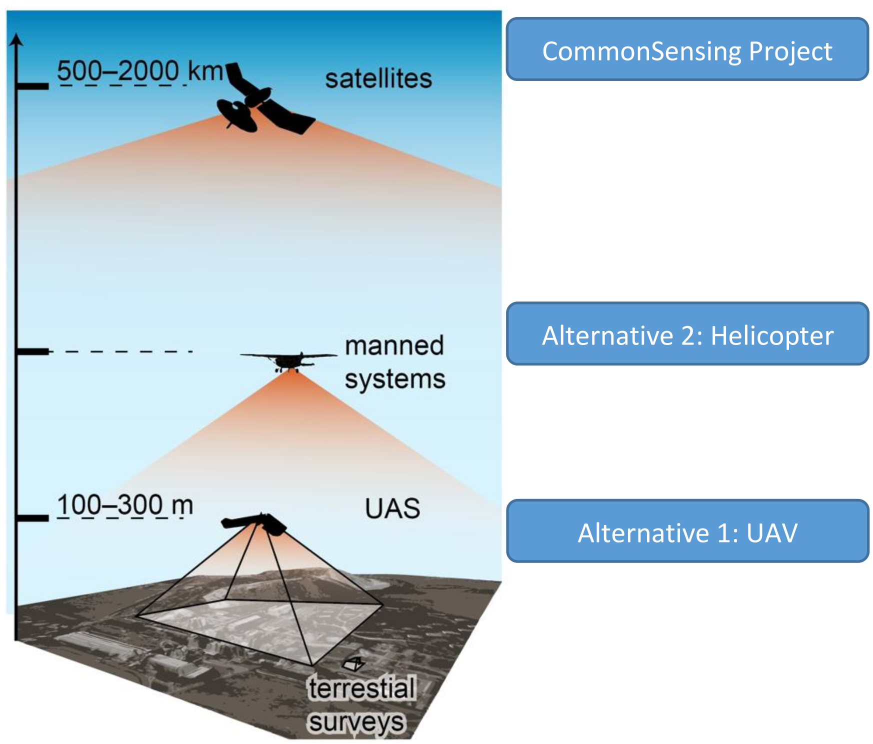

Figure 1: CommonSensing project and Alternatives

Source*: 'UAS for Wetland Mapping and Hydrological Modeling' (Jeziorska, J., 2019)*

[9] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/768556/average-year-to-december-2018.csv/preview (last visited (1/05/20)

10 Fuel costs are nevertheless volatile to market considerations.

2.2. Costs

19. The CommonSensing project budget includes the costs of the identification and implementation phases. The identification phase consisted of costs for drafting the project, international travel, labour and other related costs. The costs of the implementation phase include the real costs of acquisition and processing the satellite imagery, development and testing the methodology proposed by the project. Concretely, this encompasses the development and piloting of the Spatial Decision Support System, the CommonSensing web portal, EO data cubes, weather and climate data and models, and food security modelling and simulation. The estimated costs of the project include project management, field operations, training, and studies (e.g. sustainability plan), demand-driven backstopping activities (mainly in the form of studies and/or technical assistance and other costs).

20. As discussed under limitations, the CommonSensing project is a multi-country project, but the full solution is only to be implemented in Fiji. However, many of the project's activities target beneficiaries from the three countries (e.g. training) which create economies of scale but also make it difficult to break down costs per country. Hence, the CEA is calculated for the whole project, although the proposed solution will be implemented only in Fiji. This is a major limitation.

21. The project started in 2018 which, therefore, has been considered the starting year of the project (not 2017, like other IPP projects). For 2018 and 2019, actual costs are used to calculate the CEA. During these first two years of the project, 55.17 per cent of the budget has been expended. Since the budget breakdown per year is not available, the costs are equally allocated to both years. Costs for 2020 are forecasted based on the remaining budget (44.83 per cent). The CEA also considers the forecast for a two-year extension of the project, which corresponds to the impact of the action in the medium term as well as to the expected results associated with the sustainability plan designed and implemented during the project. In the present CEA, it is assumed that the costs to be incurred for these two additional years would be the same as the final year of the project because the costs of the two last years were considered to be too high to just cover the fewer costs of project liabilities.

22. Finally, it is important to highlight that 20 per cent of the total budget has been deducted from the budget since this accounts for costs (M&E and a proportion of project management costs) that would not be incurred in a commercial. However, project monitoring and self-evaluation costs (e.g. assessment of learning) have not yet been fully deducted (only independent evaluation costs), as this information has not yet been provided by project management. This does not apply to the two alternatives. Alternative 1 has 10 per cent of the total budget devoted to management costs, and M&E is not considered. Alternative 2 does not include M&E costs, and it will be assumed that it has the same management costs as the CommonSensing project.

2.3. Impacts

23. The CommonSensing project identifies six medium−long-term impacts, measured through 15 indicators. The primary impact is defined as: 'By 2030, enhanced disaster risk reduction and climate change resilience in Fiji, the Solomon Islands and Vanuatu in support of SDG 13 (Climate action) and SDG 9 (Industry, innovation and infrastructure)', to be measured through six indicators that assess many of the variables that should contribute to the achievement of these two SDGs, from the number of lives saved to the increase of funding

available to address the challenges related to these SDGs. For the CEA, the project's impact indicator '10.3.1: Amount of climate-related finance available from all sources' was selected. This indicator is understood as the increase of funding available to address climate change resilience and adopt disaster risk reduction measures that can be accrued from having used EO solutions to apply for climate-related finance grants.

24. As mentioned above, there are other project impacts, but they are not considered in the CEA analysis because of data unavailability or reliability issues. The data for this indicator was recently gathered through a baseline study carried out in 2019. More precise values can be obtained from the OECD−DAC climate-related development finance database, but this information is only available for Fiji. The Solomon Islands is in the process of updating their development aid data system for climate funding, and Vanuatu is in the process of providing this information. Hence, the impact indicator's baseline data will be used as a temporary proxy.

25. This impact indicator is disaggregated per country, and the unit of measure to track progress is in percentages. Thus, baseline information is available at the country level, and the expected increase is available in percentage. For the present CEA, the baseline values had to be calculated to obtain an accumulative value, and the percentage value, translated into a nominal value.

Table 1: Impact indicator

Impact indicator *10.3.1: Amount of climate-related finance available from all sources*	Baseline for the three countries (2018)	Target for the three countries (2019)		Target for the three countries (2020)		Target for the three countries (2021)	
Fiji Increase	£43.7 million	%:0	Nom.: £0 million	%: 20	Nom.: £8.740 million	%: 30	Nom.: £13.110 million
Total Fiji:	£43.7 **million**		£43.7 **million**		**£52.44 million**		**£56.81million**
Solomon Islands Increase	£142.7 million	%:0	Nom.: £0 million	%: 20	Nom.: £28.540 million	%: 30	Nom.: £42.810 million
Total SI:	£142.7 **million**		£142.7 **million**		**£171.24 million**		**£185.51 million**
Vanuatu Increase	£100.1 million	%:0	Nom.: £0 million	%: 20	Nom.: £20.020 million	%: 30	Nom.: £30.030 million
Total Vanuatu:	£100.1 **million**		£100.1 **million**		**£120.12 million**		**£130.13 million**
Total Increase	**£0**	**%:0**	**£0**	**%: 20**	**£57.300 Million**	**%: 30**	**£85.950 million**
Total:	**£286.5 million**		**£286.5 million**		**£ 343.8 million**		**£372.45 million**

26. The accumulative value will be used as the unit of measure (i.e. £286.5 million), and the nominal values of the accumulative values of each year (2020 and 2021) represent the targets (e.g. an increase of £57.300 million and £85,950 million by 2020 and 2021, respectively). The CEA assumes that this percentage increase is based in each case on the baseline.

27. The counterfactual benefit of the indicator would be the impact achieved in the absence of CommonSensing. The project's impact will be only measured at the end of the project due to the unavailability of data at the time of mid-line evaluation (2020). It is assumed that the two alternatives will have the same impact as the CommonSensing project by the end of the project since they deliver comparable data that can be used for the same purpose.

28. Regarding the counterfactual benefit indicator, it is important to note that this might be very difficult to define, which is closely linked to the use of alternatives. In fact, the UAV solution might already have some impact on the present values (i.e. available funding) or future values. For example, Vanuatu and Fiji have already introduced drone-based solutions to prospect the damage caused by Cyclone Palm (2015) and Cyclone Winston (2016) in Fiji. Information and data obtained might have been used (or is still used) to draft applications for climate-related finance released in 2019 or later. A similar assumption could apply to climate-related finance received in 2020 and 2021, when an increase in climate-related funds could be attributed to the response to Cyclone Harold (2020) and drone-based and aerial (plane/helicopter) means were used to assess the damages. This leads to a conclusion that, on the one hand, defining a counterfactual case based on 'no type of intervention' is not an option, and, on the other hand, that many attribution issues are expected at the time of measuring the increase of the amount of climate finance available from all sources.

2.4. Standardized

29. The budgets of both alternatives were calculated using 2018 values. Cyclone Gita occurred in 2018, so the WB project contained 2018 prices. Furthermore, where costs come from the desk review, the studies used as reference were published in 2019, so prices were likely to correspond to 2018 (although this is not confirmed). We assume the inflation discount factor was not necessary since prices for 2018 were available.

30. Concerning the use of exchange rates to calculate CEA ratios, the CommonSensing budget provided the costs in GBP, including the value of in-kind contributions. However, exchange rates were used to determine the costs of the alternatives in GBP. Costs for both alternatives (1 and 2) were all calculated in US$. The budget of Alternative 1 was in US$, as this is the official currency of World Bank operations. In the case of Alternative 2, prices were found in US$. In both cases, the average exchange rate for 2018 was used to convert the costs of the alternatives in US$ into GBP. The annual average exchange rate applied was 1$ ≅ 0.75 (0.7443) GBP[11]. Inflation rates are also necessary to adjust. Since this is a multi-country project, an inflation rate needs to be calculated for all three countries. This was done by calculating the average inflation rate of the three countries for 2018. The result obtained is a 3.2 per cent inflation rate, rounded to 3 per cent.

[11] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/768556/average-year-to-december-2018.csv/preview (last visited (1/05/20)

Table 2: Average Inflation rate for the three countries in 2018

Year Inflation Rate per country	2017	2018	2019
Inflation rate Solomon Island	0.50%	2.70%	0.40%
Inflation rate Fiji	3.40%	4.10%	3.50%
Inflation rate Vanuatu	3.10%	2.90%	2%
Average inflation rate per year (rounded)	2.3% (2.5%)	3.2% (3%)	1.96% (2%)

31. Finally, before proceeding to the completion of the CEA tool, the following discount factors were confirmed:

Table 3: Discount Factors

Year	Rate	2018	2019	2020	2021	2022	2023
UK Green Book discount factor	3.5%	1.00	0.97	0.93	0.90	0.87	0.84
Average of annual inflation discount factor: SI, Vanuatu, Fiji	3.0%	1.00	0.97	0.94	0.92	0.89	0.86
UK inflation discount factor	2.0%	1.00	0.98	0.96	0.94	0.92	0.91

3. Compute, Report and Conclude

32. The costs of both alternative solutions to EO, Alternative 1: UAV-based solution and Alternative 2: Aircraft-based solution (helicopter), have been used to calculate cost-effectiveness ratios (Figure 2) to compare with the satellite solution cost-effectiveness ratio of the CommonSensing project. In all three cases, the expected result from the solution is increased access to climate funds, as it is assumed that these technologies would introduce improved tools and capacities to make decisions and, in turn, lead to increased climate financing through more and better proposals to climate funding mechanisms. The method also calculates CE ratios that allow a comparison of the CE of CommonSensing and alternatives beyond the project implementation period and determines whether the project is increasing cost-effectiveness in scale. Based on the costs and impacts previously listed, the satellite-supported method has a CE ratio of 0.087 during project implementation period (2018-2020), while the UAV method is 0.338 and the aircraft solution is 0.141.

Figure 2: Cost-Effectiveness Ratios 2018-2021 and 2022-2023

		Start-2021	Start-2023
IPP Project	Present Value of TOTAL COSTS	18.622.794	27.274.286
	Present Value of IMPACT	213.119.539,09	360.387.592,25
	COST-EFFECTIVENESS RATIO	**0,087**	**0,076**
Alternative 1	**UAV based Solution**		
	Present Value of TOTAL COSTS	72.017.561	143.743.240
	Present Value of IMPACT	213.119.539,09	360.387.592,25
	COST-EFFECTIVENESS RATIO	**0,338**	**0,399**
Alternative 2	**Aircraft Surveying**		
	Present Value of TOTAL COSTS	29.982.235	48.028.520
	Present Value of IMPACT	213.119.539,09	360.387.592,25
	COST-EFFECTIVENESS RATIO	**0,141**	**0,133**

33. This means that for each £1M spent on satellite supported analysis would capture around £12M additional funds – more than the UAV method (around £3M) or the aircraft method (around £7M). The space-based solution is therefore the most cost-effective solution for the years covering project implementation. The helicopter solution is assessed between the other two solutions with a CE ratio close to the satellite CE ratio: 0.141. The use of UAV is an expensive non-space-based solution in the short-term with a ratio of 0.338.

34. In the subsequent period from 2021 to 2023, the ratios for the satellite and helicopter solutions decrease less than 10 points; however, the space-based solution continues to be the most cost-effective, with a ratio of 0.076. Actually, the CE of the space-based solution seems to decrease considerably overtime (from 0.087 to 0.076) with respect to the other two solutions. This means that the helicopter method could have a similar impact as the satellite method in scale, although the acquisition of data and operationalization seem to be much more expensive than EO. The UAV method, however, increases from 0.338 to 0.399 during the legacy period, which means that this solution is expensive to be implemented in a commercial context and deemed as unaffordable for partner countries.

35. These results are similar to those found in the desk review of studies that also compare the CE between the use of satellite or aircraft in different sectors, from land and wetland mapping to other agriculture, food security or real estate purposes. In all cases, the space-based method is the most cost-effective solution in both quantitative and qualitative terms and in the short and long run. In all cases, the Pound cost per unit of effectiveness of the satellite-based solution appears lower than the aircraft solution. Part of this cost-effectiveness is attributed to the fact that EO can be implemented quicker, provide better precision and accuracy of the areas mapped and reduce production costs (Bernknopf et al., 2019)[12]. Nevertheless, it is important to highlight that although the use of aircraft might seem more expensive overall for small areas but less for larger areas (economies of scale), companies in the sector are introducing new technologies to bring the costs of surveying using helicopters or planes down in front of the competition of drones and satellites[13]. This method can also provide a higher imagery solution than satellite, which can become more cost-effective depending on the purpose of the project/image analysis as well. Nevertheless, it was also noted that, with the low costs and resolution of satellite imagery and the fast improvement of drones' capabilities and endurance, helicopter and other aircraft solutions are threatened with disappearing (Bernknopf et al., 2019; Deane et al., 2019).

36. Today, drones appear to be the most expensive and probably least realistic solution for the type of uses and services provided by the CommonSensing project. They require much more time to collect data due to battery life or limited coverage of the territory per flight and, in turn, more operational costs in terms of human resources and mobility (i.e. internal travel). Indeed, many studies concluded that drone-based solutions might not be the most cost-effective for generating data imagery covering larger areas, in this case, countries, as is the case with CommonSensing. This may change in the future as UAV companies improve drone endurance. Nonetheless, it is important for the analysis to highlight the advantages of UAV that satellite and helicopter methods cannot offer and when its use seems more cost-effective. Drones can fly at very low altitudes and in some terrains to just a few centimeters above the ground, providing high-resolution data imagery with different oblique angles. These data are is very important, for example for food security matters or assessing public infrastructures (Deane et al., 2019; Fitzpatrick, 2016). Additionally, drones seem more cost-effective than the other two methods for smaller projects, where limited areas need to be surveyed, for example, for mapping areas damaged by cyclones for fast emergency response. As many studies have found, including the World Bank project's use as a reference for calculating costs of the drone-based solution in the Pacific, the drone-based solution is the most cost-effective option since drones are easy to deploy and can carry out mapping in unfavorable weather conditions e.g. when there is cloud cover). Moreover, they are easy to manage and process and can better assess damage to infrastructures, buildings, or landslides with more precision, which is very important in the case of damage assessment from earthquakes or cyclones.

37. Finally, in a CEA, it is equally important to assess the environmental and social impact of these alternatives. Although this type of impact might seem irrelevant at first sight because it does not affect the costs of the project, it might be when looking at the potential consequences of using one or another solution in a developing country context. For

[12] Also in https://droneapps.co/case-study-drones-to-transform-viticulture/ (last visited 30/04/2020)
[13] Also in https://droneapps.co/case-study-drones-to-transform-viticulture/ (last visited 30/04/2020)

example, some countries might not have regulations for UAV flights (like in Vanuatu where Australian regulations are used). Alternatively, local communities living in rainforests with a land custom system (as in the three target countries) might oppose invasive drones or helicopters flying over their territory, hindering the implementation of the project while incurring more costs and implementation time. In addition, the use of helicopters and drones leaves a considerable carbon footprint[14], which results in incalculable costs for the environment in the medium and long term. In this sense, the satellite-based solution appears the less invasive method in social terms, as it should not introduce any disruption to community life, as well as the most environmentally sustainable since its use does not have a direct impact on the environment. Thus, the satellite-based solution also appears to be the most cost-effective in social and environmental terms.

4. Risks and Limitation

38. As previously indicated, several choices and assumptions had to be made to proceed with the CEA. These, of course, involve taking methodological risks hereafter exposed.

Table 4: Risks and Mitigation Measures

Risks	Possible Mitigation Measures
The CommonSensing Project includes the use of drones to address data gap issues. The cost of drone-related activities is £16,412 and includes training, local and international travel, and other costs. Hence, there are CommonSensing project risks of not being considered a fully satellite-based solution.	*Deduct the costs of drone-based activities from the budget.* *Drone-related activities are only for research purposes 'to help fill a "data gap" problem with the satellite remote sensing' and should not modify the nature of the satellite-based solution. Therefore, a deduction is not necessary.*
The assumption that some of the activities will have the same costs as CommonSensing means that the alternative also includes a partially drone-based solution. In the case of alternative 1, this might overlap with some costs, mainly for training. In the case of alternative 2, this changes the nature of the alternative from a total aircraft method to a mixed method that combines drones and aircrafts.	*Recalculate the costs of those activities considered in the alternatives after deducting the costs of a drone-based solution.*
Alternatives 1 and 2 might be underbudgeted. Since a field mission was not carried out, the budget was developed based on secondary data, mainly from research documents and project documents that used these methods for different purposes. Both alternatives could be more expensive.	*The CEA will be reviewed at the end of the project. Since the costs might be higher than those considered in the present CEA, underbudgeted issues should not change the main conclusions of the CEA.*
Small budget discrepancies can be observed between the total budget of the project as per the project document (£24,269,759) and the total budget used for the CEA (£24,781,501). This might	*The CEA will be reviewed at the end of the project when more information about actual expenditures is available. Adjustments to the percentage of UK*

[14] This is not to say that satellite is carbon neutral. This is based on the assumption that the project does not include to launch a satellite, rather based on the use of an existing satellite.

be due to various reasons, from exchange rate differences to issues related to the provision of matching funding which is not provided in cash but simply deducted from replenishments or mismatches between actual and forecasted costs.	*matching funding are made by the end of the project.*
Attribution risks due to COVID-19 and Cyclone Harold. In April 2020, the three target countries were hit by Cyclone Harold, leaving important damages in some of their main islands[15]. This will likely imply an increase of available funds for both emergency and recovery (post-disaster), making it very difficult to measure the impact of the CommonSensing project. In addition, a declaration of a state of emergency due to COVID-19 might have created delays in the project implementation which might incur additional costs that today are not considered.	*Introduction of variables of control or contribution analysis and financial adjustments might be required in the end-line evaluation and final CEA.*

39. The present CEA also encountered at least six limitations:

- The costs of alternatives are estimated since it was not possible to cross-check and validate these costs in the field because of the COVID-19 health crisis.
- The budget breakdown was not available per country or per year.
- It is assumed that the costs of the three additional years (legacy) are the same as those incurred in the last year of the project (2020). However, this assumption might not be realistic as more than 44 per cent of the total project cost remains to be spent in the last year of the project. This accumulation of budget in the last year might be due to different issues, among them capacity of absorption of partner countries (which is very low, as already identified as a risk factor) and delays caused by COVID-19, among other reasons. An alternative option would be to consider the average costs per year as the costs for the additional year.
- Limited information and research is available on the use of alternatives to space-based solutions, particularly in the Pacific countries.
- Targets will be only assessed by the end of the project due to unavailability of climate finance data in Vanuatu and Solomon Islands.
- Full M&E costs cannot be deducted at the present time.

[15] E.g. Santo Island in Vanuatu, the second most important island in the country, or Mamanuca and the Yasawa Group in Fiji, the most touristic places.

5. Next steps

40. This interim CEA report will be presented to the CommonSensing project management and comments addressed prior to the interim report being finalized. While the report is intended to be a stand-alone product, it should be read in conjunction with the mid-line evaluation of the CommonSensing project and in particular the findings and conclusions on project efficiency, as well as any related recommendations. The interim CEA report will be updated during the first quarter of 2021 based on additional project expenditures and cross-checking on budgets and actual costs of the alternatives.

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