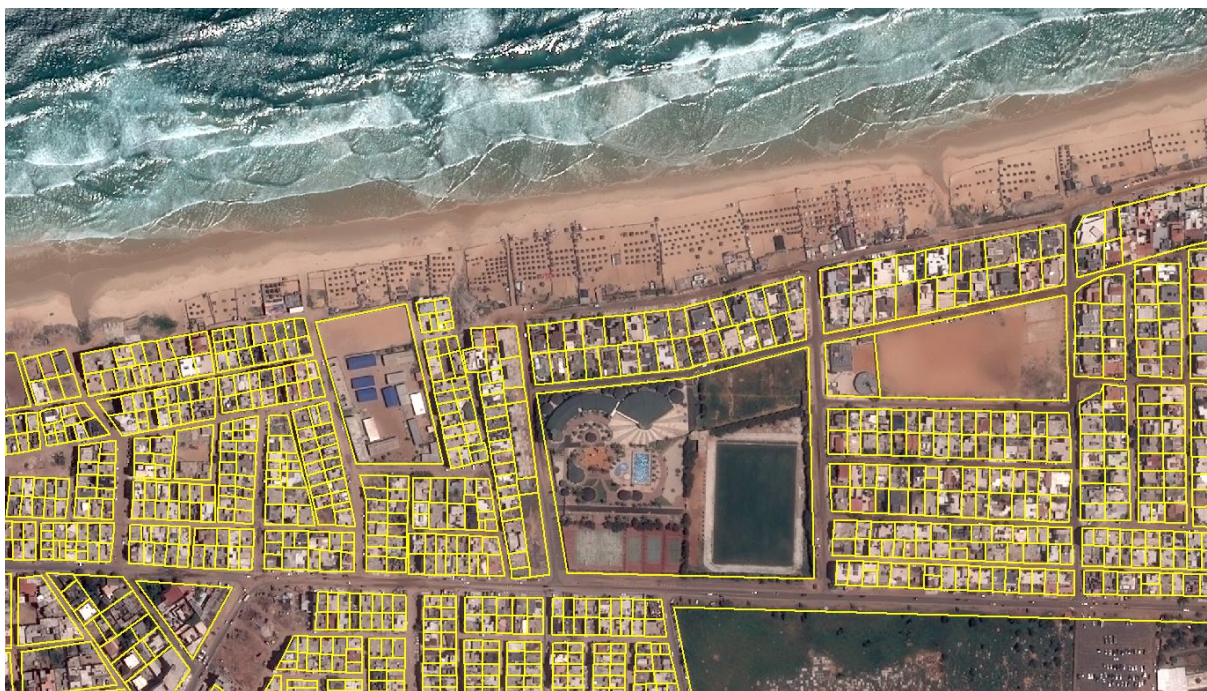


**Airbus Defence & Space:
Satellite Image Analysis for Operational
Maintenance of a Property Database for
Dakar City, Senegal**



M&E Legacy Evaluation Report

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May, 2020

1. Table of Contents

1. Table of Contents.....	2
2. Abbreviations and Acronyms.....	4
3. Executive Summary	6
4. Background to the Legacy Evaluation	13
4.1 Introduction	13
4.2 Project Overview.....	13
5. Purpose and Scope	16
5.1 Purpose	16
5.2 Scope of the Legacy Evaluation.....	17
6. Methodology	18
6.1 Dakar Legacy Evaluation	18
6.2 Limitations to Methodology	19
6.3 Legacy Evaluation Questions.....	20
Relevance.....	20
Effectiveness	20
Efficiency	21
Impact.....	21
Sustainability.....	22
What will be the counterfactual analysis?.....	22
6.4 Optional Second Country Legacy Evaluation	22
7. Legacy Evaluation.....	24
7.1 Engagement on Project Impacts of Revenues and Services	24
7.2 Potential Users of Satellite Data in Senegal in Government.....	26
7.3 Private Sector and other users of Satellite Imagery.....	30
7.4 Airbus Activities – Promotion, Support and Technical Effort.....	32
7.5 Research	35
7.6 Legacy Summary Using the OEDC DAC Criteria	37
7.7 Sustainable Development Goals (SDG's)	40
7.8 The Logical Framework (LogFrame)	41
8. Logical Framework Tables	44
9. Review of Actions Taken as a Result of the Endline Evaluation Report	53
9.1 Review of Endline Future Actions	53
9.2 Future Actions (beyond the Legacy Evaluation).....	55
10. Conclusion	56

10.1	Assessment of likelihood of achieving further impacts	56
10.2	Assessment of likelihood of future procurement in Senegal and other countries ...	58
10.3	Sustainable Development Goals	59
10.4	Learnings	59

2. Abbreviations and Acronyms

Airbus	Airbus Defence and Space Ltd.
ADIE	Agence de l'Informatique de l'Etat
ADL	Agence de Développement Local
ADM	Agence de Développement Municipal
ANAT	Agence Nationale de l'Aménagement du Territoire
ANSD	Agence Nationale de la Statistique et de la Démographie
APTI	Africa Property Tax Initiative
BEIS	Department for Business, Energy & Industrial Strategy
BRT	Bus Rapid Transit (project)
CEA	Cost Effectiveness Analysis
CEO	Chief Executive Officer
CETUD	Le Conseil Exécutif des Transports Urbains de Dakar
CFA	Communauté Financière Africaine (African Financial Community)
DAC	Development Assistance Committee
DGID	Direction Générale des Impôts et des Domaines
DFID	Department for International Development
DSM	Digital Surface Model
DTGC	Direction des Travaux Géographiques et Cartographiques
DTM	Digital Terrain Model
EO	Earth Observation
FIG	Fédération Internationale des Géomètres (Surveyors)
GCRF	Global Challenges Research Fund
GIS	Geographic Information System
HR	Human Resources
ICTD	International Centre for Tax and Development
IFI	International Financing Institution
IGC	International Growth Centre
IPP	International Partnership Programme
IT	Information Technology
KPI	Key Performance Indicator

LAVIMS	Land Administration and Valuation Information Management System (Mauritius)
LG	Local Government
LSE	London School of Economics
LTR	Land Tenure Regularisation
M&E	Monitoring and Evaluation
MOU	Memorandum of Understanding
MASP	Municipal and Agglomerations Support Programme
NAC	New Africa Consulting
NSDI	National Spatial Data Infrastructure
ODA	Official Development Assistance
OECD DAC	Organisation for Economic Co-operation and Development, Development Assistance Committee
PNG	National Geomatics Plan
PPP	Public Private Partnership
PPPSL	PPP Solutions Ltd
PSE	Plan Sénégal Emergent
PSoE	Paris School of Economics
QA	Quality Assurance
RICS	Royal Institution of Chartered Surveyors
SDG	Sustainable Development Goal
SMART	Specific Measurable Achievable Relevant Time-bound
UKSA	United Kingdom Space Agency
UN	United Nations
UN-GGIM	United Nations Global Geospatial Information Management
WB	World Bank
3D	Three-dimensional

3. Executive Summary

Maintaining up-to-date and accurate information about all assets and services owned and operated by organisations is essential for good governance. Often insufficient attention or resources are provided to ensure this occurs and in rapidly changing environments, such as exist in the developing world where increasing urbanisation is a major factor, information about land and property is all too often inaccurate, considerably out of date and not maintained in any meaningful way.

The Dakar Change project commenced in January 2017 and was completed in December 2018, with final reporting completed in February 2019. It was undertaken by Airbus and local partner, New Africa Consulting (NAC), with funding from UK Space Agency (UKSA) under their International Partnership Programme (IPP). The project concerned the use of satellite imagery as a means of detecting change to buildings to be used to assist in developing a city-wide property-based revenue generation system for the city of Dakar in Senegal. It was developed because of the prior experience of Airbus Defence and Space in Senegal in the broad area of land administration and how geospatial applications could be utilised to improve efficiency in the management of property data. In doing so, the project provided the means to keep a database of land and property up-to-date at minimal cost.

However, although the project had a technical base, it was also set up and delivered to ensure that the principal OECD/DAC evaluation criteria had been met. At the end of the project, an Endline Monitoring and Evaluation Report was presented in order to “determine the relevance and fulfilment of objectives, developmental efficiency, effectiveness, impact and sustainability” of the project in line with the five criteria OECD/DAC members use in guiding development aid: references <http://www.oecd.org/dac/evaluation/50584880.pdf>, and, <http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm>.

The purpose of this Legacy Evaluation, undertaken in February/March 2020 (just over 12 months after project completion) was therefore to:

1. Document if and how the methodology and operation of change detection has been used since project close to support the development of a holistic property tax system in Dakar and, in addition, if/how it has complemented other ongoing initiatives in Senegal;
2. Determine the progress of the project in contributing to the achievement of the SDGs, including, specifically, Goal 17.1: Strengthen domestic resource mobilisation, including through international support to developing countries to improve domestic capacity for tax and other revenue collection;
3. Re-validate the business case (for Airbus) that significant benefits will be accrued through using space technology for property valuation purposes by confirming the business opportunities (and status) for similar projects in other cities and areas in Senegal and (especially) in other cities globally; and,
4. Assess progress towards the realisation of a property tax system and the role of monitoring property change in the city of Dakar.

In addition to the main legacy focus on Dakar, and based on the target impact of generating interest in the methodology in new countries, the preparation for the Legacy Evaluation did consider the option of undertaking an assessment in a second target country. This was based on the possibility of a country (where Airbus has already initiated discussions) taking some concrete steps towards implementing the urban change monitoring methodology. The candidates to be considered were Uganda, Kenya, Ghana and Sierra Leone. Unfortunately none of the opportunities currently under review had progressed sufficiently for an evaluation to be worthwhile in early 2020, although all are still being pursued as active opportunities. (Note that travel restrictions applicable in mid-2020 have further delayed this process.)

This Legacy Monitoring and Evaluation Report is a review of both the Endline position and the activities, events and progress that have been made in the year since project completion. The following table summarises the Legacy developments, as evidenced by the DAC five criteria and is essentially an update of the table originally presented in the Endline Report.

DAC Criteria	Legacy Assessment
Effectiveness	<p>The Legacy assessment confirmed from many sources (Government bodies and the private sector) the importance of a satellite change detection system as an effective means of data maintenance for land parcels, feature mapping, a property database and, especially, as the foundation for an effective operational cadastral database.</p> <p>Whilst tax revenue collection is important for developing city services, and therefore monitoring changes to the database are equally important (and the continued existence of global research and pilot programmes into property tax substantiates this), some of the barriers to be overcome still exist in the form of the production of an accurate database to begin with and the politically sensitive nature of the subject.</p> <p>The positive action taken during the IPP project and continuing in Legacy has been to maintain contact with the primary stakeholder, Direction Générale des Impôts et des Domaines (DGID), and understand and contribute to the ambition of a National Cadastre and to also contribute to the DGID / PSoE (Paris School of Economics) pilot project of gathering property attributes for valuation purposes pursuant to the later (possible / probable) implementation of a valid property tax system.</p>
Relevance	<p>Change detection (or database maintenance) continues to be identified by all stakeholders as a key requirement. The meetings held with both government and private sector stakeholders further emphasised this by identifying, for example: new applications including the importance of monitoring changes to land and property within municipalities coupled with the use of satellite imagery to derive a municipal boundary map; the identification of properties and the changes thereof for an Agence de Développement Municipal (ADM) financed addressing project; for the improvement of the customer databases of utility companies; as a software enhancement to the DGID / PSoE pilot tax project; to improve topographical mapping; and, as a shared data resource for the Senegal</p>

	<p>IT Agency ADIE (Agence de l'Informatique de l'Etat).</p> <p>Evidence from Airbus experience across Africa and research on the topic, including DFID and World Bank funded projects, confirms that the use of this technology is relevant to many other countries and cities. This is also the background to two Airbus initiatives in 2020:</p> <ul style="list-style-type: none"> • the Africa4Future Airbus programme supporting SME's operating as start-up software and service companies in developing new applications in infrastructure and agriculture, and: • A Space Day Seminar / workshop planned in Dakar in April 2020 to which senior politicians and officials from Senegal government departments will be invited (now postponed to October 2020).
<p>Efficiency</p>	<p>No additional technical work was carried out after project completion in January 2019, although an important step was taken in the development of a web interface to enable users and interested parties to access an application demonstrating the project results. Feedback from stakeholders given the application is awaited. However, the indication from all stakeholders with whom the project was discussed is that the method could be a more efficient method of updating property information than field-only based methods.</p> <p>No update to the Cost Effective Analysis was undertaken as no new data was available. The Endline CEA confirmed positive results from the project.</p>
<p>Impacts</p>	<p>The project impacts were all achieved by January 2019 but, without the clear implementation of the technical solution pending acceptance by DGID, and, pending decisions on the greater priority of a National Cadastre, as stated elsewhere in this report. In terms of the use to which improved revenues could be allocated the strategy outlined in the Resilient Strategy is clearly still valid but financial resources will have to be accessed, in the short term, from other areas than property taxation. Relevant factors may be:</p> <ul style="list-style-type: none"> • the "replacement" to the 100 Resilient Strategies organisation in the form of the Global Resilient Cities Network, https://www.rockpa.org/project/global-resilient-cities-network/ • Another programme called the "Global Platform for Sustainable Cities" (https://www.thegpsc.org/) including a specific Dakar project, EO4SD-Urban Project: Dakar City Report, https://www.thegpsc.org/knowledge-products/geospatial-data-and-indicators/eo4sd-urban-project-dakar-city-report • The MASP Programme in which ADM plays a leading role which will rationalise the financial relationship between national and local governments <p>Finally research and contacts made in Dakar and elsewhere confirm that the change detection methodology has significant applications for other organisations in Senegal and elsewhere globally.</p>

Sustainability	<p>Sustainability has been “witnessed” in a number of ways relating to project and activities some of which are as follows:</p> <ul style="list-style-type: none"> • The promotional activities being undertaken by Airbus stated above under “Relevance;” • New Africa Consulting’s new utility customers who will be advised of the opportunities for using change detection to enhance their database of customers; • DGID in conjunction with PSoE and their software partner, Idyal, may introduce a geospatial element to their data collection if Airbus collaboration with Idyal can be implemented; • The clear indication from the leading Senegal geospatial organisations of ADIE and DTGC (Direction des Travaux Géographiques et Cartographiques) that cadastral data forms a base foundation dataset upon which many business developments and economic development is dependent; • The knowledge of the importance of geospatial data and the sharing of such data (as promoted by ADIE) is exemplified by the publication of the National Spatial Plan and the National Geomatics Plan; • Most important of all is the publication of the Plan for an Emerging Senegal (PSE). This is a strategy, which constitutes the benchmark for economic and social policy in the medium and long term, whereby Senegal has decided to adopt a new development model to accelerate its march towards emergence. Within this plan is a complementary plan of Senegal Digital 2016 – 2025 which “embodies Senegal's ambition to maintain a position as an innovative leading country in Africa in the digital field.” <p>https://www.sec.gouv.sn/dossiers/plan-s%C3%A9n%C3%A9gal-emergent-pse https://www.sec.gouv.sn/dossiers/s%C3%A9n%C3%A9gal-num%C3%A9rique-2016-2025</p>
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At Endline, all of the major project targets had been achieved:

- the software technical solution had been created, successfully trialled and operated by trained local partner staff;
- quality assured data, digital maps, identification of land parcels and a simplistic (as requested by DGID) valuation model were successfully produced and an estimated potential revenue take for Dakar calculated;
- stakeholders with an interest in the use of satellite imagery had been contacted in Dakar and globally and Airbus had engaged in ongoing discussions with them. Many of these were borne out of presentations at international conferences and public awareness events;
- the proposed new method using the change detection satellite-based solution has proved in the CEA to be a more efficient method of operations compared to other possible methods, noting also that no data maintenance is currently undertaken by DGID; and, finally
- the potential for increased tax does exist and would be of great benefit in Dakar (and Africa) to be used for improving local authority services to citizens.

As written in the Endline Report, *“The relationship between change management and tax revenue is important to understand. DGID, the main beneficiary, fully understands the implications of having an up-to-date database (as do other stakeholders) but have prioritised the requirements of implementing a National Cadastre, with survey accuracies well in excess of the requirements of any tax applications. The ongoing PSoE project which is consulting on a modernised tax management system may have implications and find a way through the impasse by emphasising or explaining relationships between cadastral and tax requirements (as will any ongoing discussion by Airbus with DGID, post IPP project).”*

As a result of the Legacy Evaluation, it was found that circumstances have not significantly changed this statement. Although some personnel changes have taken place and some reorganisation at ministry level, the fundamental requirements of PSE (Plan Sénégal Emergent) have not changed and both the National Cadastre and property tax reform remain high on the agenda although both of these, along with many activities in Senegal in 2019 did not move significantly forward; significant government reorganisation was frequently noted by stakeholders as a contributor to this.

During the post-project period, relations with the local partner have been actively maintained and we are together identifying opportunities to take the work further, including providing a potential change monitoring service to the utilities. Based on the general experience gained on the IPP project, the local partner, NAC, is also currently providing field data collection services to utilities in order to enhance their customer database in several towns outside Dakar.

The Endline Report set out a number of actions to be carried out after project completion. These are shown below and against each is a comment on the action that was taken during the Legacy period (January 2019 to February 2020). In many cases details of these actions are described in the body of this Legacy Evaluation Report and so the appropriate references are made.

Identified Endline Activity	Legacy Evaluation Update	Likelihood of Success
<p>Airbus will continue to liaise with DGID and to arrange meetings with influential and internationally respected UK organisations in the land and tax domain in order to demonstrate the importance of the monitoring strategy. This could include RICS and HM Land Registry with whom Airbus has good relationships. In particular RICS have been very supportive to Airbus in recent land, valuation and tax investigations by prospective Airbus clients emphasising the importance of international standards and “Fitness for Purposes” methods.</p>	<p>This has been continued through meetings with DGID at regular intervals throughout the year. In addition a technical workshop was held in July 2019 with participants invited by the new Director of Cadastre, including participants from other relevant stakeholders ADIE, DTGC, and ADM.</p> <p>Interaction with RICS and HMLR has also been continued in order to ensure that ‘best practice’ processes are presented where applicable.</p>	<p>The potential success is dependent upon securing sources of funding. Contacts with several DFIs are continuing.</p>

<p>Continued liaison with PSoE on their project - to review progress and their comments on the apparent and perceived conflicts between tax and cadastral requirements. Recent contact with APTI via Management Committee Member, Mr Paul Fish, who is acting as a valuation consultant on the project will also help.</p>	<p>Contact maintained with PSoE in order to review their research progress. Local software partner is a potential partner for developing operational property tax field data collection software. Preliminary discussions have taken place</p>	<p>Use of a local software developer with a tablet-based data collection application will be useful for any future operational activity and an essential component of data maintenance.</p>
<p>Preparation of brief documents explaining how the change detection system can be deployed and used in different land administration situations and drawing attention to different requirements for tax and cadastre. This to include, using the CEA data, the opportunity cost of doing nothing in terms of revenue collection.</p>	<p>This was established through the presentation of a paper at the World Bank Land and Poverty meeting in March 2019 which focused on the project CEA.</p> <p>The main conclusions were also presented at the AfricaGIS conference in Rwanda in November 2019.</p>	<p>An overview of the project and the principal CEA results is now in the public domain and can be included in future project proposals for data maintenance.</p>
<p>Continued liaison with the UK Ambassador in Senegal who has taken a keen interest in the work of Airbus and IPP and has offered to brief senior Government staff on future developments.</p>	<p>Contacts have been maintained, including with the new ambassador and other embassy staff, including the new DFID investment advisor.</p>	<p>The project and future developments have been supported by the embassy on several occasions.</p>
<p>Continued liaison by Airbus with DGID on their main priority of the National Cadastre to understand the issues from their viewpoint.</p>	<p>This has also been the main Airbus focus and is now also linked to the concept of a Spatial Data Infrastructure within the requirements of Digital Senegal, and involving all the key stakeholders.</p>	<p>This is an ongoing opportunity but it is also fully dependent upon securing finance.</p>
<p>Continued contact with NAC, our local partner, to identify opportunities for both publicising the change detection techniques and realising benefits of using satellite data.</p>	<p>This has resulted in solid opportunities for supporting the utilities with urban change mapping which are currently being discussed with prospective clients.</p>	<p>Solid opportunities for urban change mapping.</p>

During the period between the Project Endline and Legacy Evaluations progress has been maintained. It is also the intention that developments will continue in the next months, subject to lifting the international travel restrictions that started in March 2020.

With continuing interest in revenue generation from property taxation in Senegal and in several other countries, these key future activities will include:

1. Maintaining regular contact with DGID to discuss, and hopefully to help implement, a national cadastre and/or property tax regime in the future;
2. Continued contact with the stakeholders who expressed significant interest in the project and the use of satellite imagery, chief of which are ADIE, ADM and DTGC. All of these organisations are also key players in development of a future Spatial Data Infrastructure for Senegal;
3. Continuing to work with relevant international and national organisations to develop a data maintenance culture in the sector;
4. Continued contact with the World Bank, DFID and other DFIs in relation to the process of urban change monitoring;
5. Continuing to review ATPI and ICTD literature and identify where urban change monitoring could help;
6. Writing an updated overview of the solution as part of the marketing process;
7. Continuing to look at international conferencing opportunities including, for example, contributing papers and articles in magazines.

Based on the situation at Endline and the further activities and developments up until the Legacy Evaluation, Airbus remains positive about the future opportunities for an urban change monitoring service based on the frequent acquisition of Very High Resolution Satellite data such as Pleiades (50cm data) and Pleiades Neo (30cm data, available later in 2020).

It is anticipated that the higher resolution data from Pleiades Neo will further improve both the timeliness and availability of satellite data. It will also significantly improve the economics of detailed change monitoring compared with either aerial photography or, except in relatively small study areas, UAV or drone acquired data, as documented in the project Cost-Effectiveness Analysis.

However, whilst the key stakeholders in Senegal are aligned in their recognition of the value of property data maintenance, the most significant hurdle to implementation is finance. Both the National Cadastre and the property taxation system for Dakar (and other major towns in Senegal) require significant investment before they can be fully operational. Whilst the completion of both will enable significant economic development, revenue generation and realisation of SDGs (especially Goal 17.1), in line with national planning goals, it is the availability of financing to kick-start these activities that remains a barrier. Airbus is actively pursuing financing initiatives that will, hopefully, lead to implementation in the next 12-18 months, although the 2020 coronavirus lock-down and its economic consequences will impact on all timetables.

4. Background to the Legacy Evaluation

4.1 Introduction

The Airbus IPP project ‘Satellite Image Analysis for Operational Maintenance of a Property Database for Dakar City, Senegal’ concerned the use of satellite imagery to assist in developing a city-wide property-based revenue generation system. The project was selected for grant funding under the UK Space Agency’s International Partnership Programme and commenced in Airbus offices in January 2017, with first mobilisation to Dakar for training and operations in April/May 2017.

The Monitoring & Evaluation Plan was prepared in March 2017 and revised as Version 2 in August 2017. A Baseline Evaluation undertaken in April 2017 and reported on (8th May 2017); Midline Evaluations were conducted in September 2017 and April 2018; and, a final Endline Evaluation was completed in January 2019. All these reports fully examined progress and completed a number of actions that enabled the impacts of the project to be fully assessed. The legacy M&E assessment is the final element of this IPP project.

As well as a focus on the detailed technical aspects of the project from a Dakar viewpoint, involving the Airbus local partner, New Africa Consulting (NAC), and the ultimate beneficiary of the Senegal Government, Direction Générale des Impôts et des Domaines (DGID), attention was also focused on the application of the satellite imagery technology to other activities in Senegal and globally in the urban sector. In addition, the promotional and technical activities being undertaken by the project lead, Airbus Defence and Space, form part of the analysis. Overall, therefore, the analysis concerns not only satellite-based change detection as it impacts on the urban land/property sector but also to its possible use in other areas of human endeavour such as transport, health and education.

An important consideration which has also influenced the M&E evaluations and the approach to the work has been the Cost-Effectiveness Assessment. This research has helped to clarify demonstration of the value of the satellite technical methods and has been a key factor in the interest shown by beneficiaries in Dakar.

This Legacy Evaluation Report provides an update to the findings of the Endline Report, approximately 14 months after the Endline assessment was completed.

4.2 Project Overview

As a reminder of the scope, objectives and results of the Dakar change project the following paragraphs describe the background to the project and the key findings. The key results of the Endline Cost-Effectiveness Analysis are also included.

The Dakar City government has a requirement to generate revenues for developing and maintaining city infrastructure and services. The legal framework for property taxation is already in place, but the City lacks the resources to collect and maintain the information needed to calculate the tax due. Through the operational project in Mauritius called LAVIMS (Land Administration and Valuation Information Management System) and other projects, Airbus has developed expertise in the management of information about properties. Our systems link specific textual information such as ownership and address with location and

building characteristics, including size and value; all essential data for generating municipal revenues based on property taxation.

Using very high resolution satellite data, the land parcels and building extents (and heights) can be effectively monitored through a combination of image analysis and field data collection. Change detection through satellite orthoimagery analysis can greatly improve the efficiency of this monitoring process.

This project was designed to work with the partner in Dakar to develop an operational system for creating and maintaining a parcel reference map, whose accuracy can be further improved through GPS-based field survey, and, mapping new buildings and changed building heights through 3D monitoring based on satellite imagery. These provide the framework for field teams to collect and maintain accurate property characteristics enabling property tax calculations to be made within a fully operational system to support sustainable and transparent revenue generation for the City.

The project was supported by grant funding within the first call of the UK Space Agency's five year, International Partnership Programme (IPP). IPP is part of and is funded from the Department for Business, Energy and Industrial Strategy's (BEIS) Global Challenges Research Fund (GCRF), which supports cutting-edge research and innovation on global issues affecting developing countries. The Programme, which also encompasses forestry, land use, agriculture, marine environments, disaster resilience, health and education, and, renewable energy, is delivered in alignment with UK aid strategy and the United Nations' (UN) Sustainable Development Goals (SDGs).

The main technical achievements of the Dakar Change Project are summarised below. The principal aim was to confirm that regular use of satellite imagery can help to ensure that a property database is fully maintained and up-to-date:

- Tri-Stereo Pléiades Very High Resolution satellite Imagery in Elevation1 (one metre vertical resolution) product format is sufficient to differentiate reliably building height increases or decreases of one or more storeys as well as increases/decreases in building footprints;
- GIS Data collection software tools for parcel mapping have been developed so that land parcels can be accurately mapped from the ortho-rectified satellite images. These tools have been developed using Open Source GIS libraries and have been provided to the local data capture team in Dakar. Training of personnel has been completed and comprehensive user manuals have been provided as part of the 'minimum leave behind' of the project;
- Fieldwork updates and verification for property attributes have been undertaken with the assistance of mobile tablets with drop-down menus for key building variables (such as age, type of construction and condition). The information is collected in a central database. Such property information can be input to a revenue generation model. Training and comprehensive manuals have been provided to local personnel;
- A methodology for urban change detection has been developed using software that compares the height information contained in pairs of satellite images (acquired at least six months apart) to detect changes in building height and footprint. The land parcels are then classified as 'not changed' or 'changed.' The changed parcels are labelled according to the type of change. These analyses have been tested to ensure

that performance targets are met; in general errors of omission (missed changes) are below the target of 5% and errors of commission (false positives) are slightly above target. This means that very little real change is being missed, but the fieldwork on the ground will be visiting some parcels where there is no actual change; false positives mean that the subsequent planned fieldwork is slightly less efficient because more parcels are visited on the ground;

- From the height and area change detected parcels the detailed field work, collecting property attributes, can be planned. In Dakar, for well-established urban areas around 3% to 5% of parcels exhibit change in a 12-month period; rates in development areas are much higher (15% to 20%).

An important component of the project was to undertake a Cost-Effectiveness Analysis of the satellite-based method compared with a fieldwork-only method. Based on the results calculated in the CEA it can be confirmed that the satellite-based method of property data maintenance with targeted field work is a cost-effective solution. Analysis of the CE Ratios highlights some specific observations about the cost-effectiveness of data maintenance by the alternatives:

- Based on the costs and impacts listed, the satellite supported method has a CE Ratio of 0.317 for Dakar and the field-only method a CE Ratio of 0.647;
- On this basis, each £500K spent on the satellite-supported analysis would generate £1.6M of additional revenue, whereas the equivalent spend on a field-only method would generate only £770K of additional revenue;
- The aerial method comes somewhere between the other two: CE Ratio of 0.402. This reflects that the aerial method has the same impact benefit as the satellite-based method, but the annual costs of data acquisition are significantly higher;
- These analyses are based on the potential increase in revenue that could be achieved by having an operational data maintenance system on top of a city-wide property-based revenue system for Dakar and the forecast additional cities.
- A key driver of this improvement is the enhanced perception of the independence and fairness of the satellite-based methodology which in turn generates increased confidence amongst citizens and the increased likelihood that the rate of revenue bill payments will be improved overall.

This Legacy Evaluation is designed to ascertain whether there has been any further development impact in the fourteen months since project completion. The work was based on a Legacy Terms of Reference (ToR) agreed with UKSA in June 2019 and implemented in February 2020.

5. Purpose and Scope

5.1 Purpose

The Dakar project sought to show how a property database can be maintained by detecting changes to property (land and buildings) using satellite imagery which is acquired and analysed on a regular basis (every six months). Detailed field data collection can then be efficiently targeted towards changed properties. The updated database is then used as the basis of ensuring that taxes levied on land and buildings are fair and equitable and are based upon accurate, complete and up-to-date data.

The Legacy M&E Evaluation builds upon and updates the Endline Evaluation at both the technical and business applications levels, including an update of project sustainability. The evaluation process also continued the development of relationships with the key beneficiaries in Senegal and other interested parties and stakeholders, including those, such as the World Bank and research institutions, where specific business opportunities have also been identified by Airbus.

The Legacy Evaluation took account of and provided updates to previous comments on specific issues which impinged upon the conduct of the Dakar Change project and its future sustainability, including:

- DGID and its pursuance of two national land projects – the launching of a national cadastral programme and a project to develop a land information system;
- The status of the Dakar City Authority and its “buy-in” to the change detection technology consequent upon the previous difficulties due to senior officials being subject to legal proceedings;
- The status of the complementary land valuation research project being conducted by Paris School of Economics (although in a different location);
- The progress of a major World Bank project, the Municipal Agglomeration Support Programme (MASP) launched in early 2018 which aims to improve local government financing.
- The potential interest in the use of satellite imagery by other stakeholders and agencies in Senegal and a more global interest in the use of such technology and the action taken by Airbus to promote its use

The purpose of this Legacy Evaluation was therefore to:

1. Document if and how the methodology and operation of change detection developed through the project has been used since project close to support the development of a holistic property tax system in Dakar and, in addition, if/how it has complemented other ongoing initiatives in Senegal for the development of a new full national cadastre incorporating a land information system and a national database of land and property;
2. Determine the progress of the project in contributing to the achievement of the SDGs (for UKSA);

3. Re-validate the business case (for Airbus) that significant benefits will be accrued through using space technology for property valuation purposes by confirming the business opportunities (and status) for similar projects in other cities and areas in Senegal and (especially) in other cities globally.
4. Assess progress towards the realisation of a property tax system and the role of monitoring property change in the city of Dakar. It assessed progress of both the technical system developed by Airbus and the capacity building and knowledge exchange activities delivered by consortium partners. It will assess both process and overall impacts of the project and provide an update of the project LogFrame across all parts of the LogFrame Objectives.

5.2 Scope of the Legacy Evaluation

The key findings of the Endline Evaluation confirmed that the Dakar urban change assessment had the following principal impacts:

1. Satellite technology is seen as a cost-effective and accurate means of supporting property valuation in Africa (i.e. that the technical methodology is valid);
2. Space-based monitoring can, in combination with other resources, be used to increase property tax revenues in Africa;
3. Data maintenance in relation to land and property is very important and that an up-to-date database can have significant “spin-offs” for the whole subject area of land administration and property markets;
4. Cooperation between organisations having a common interest in the same base data is very important and data sharing can have significant benefits to all in supporting services;
5. The use of satellite data can have widespread application beyond land and property;
6. The use of satellite data can be viewed as an independent objective data source that can be analysed, using appropriate software, fairly and equitably and without bias, and, that this can send an important message to both administrators and citizens.

The evaluation of the current status of these, approximately 14 months after the completion of the project, is the principal focus of the Legacy Evaluation. The review of these elements enables assessment of the long-term sustainability of the technical approach and identification of any further long-term developments arising from the IPP project, either directly or indirectly. The following sections outline the methods used for the Legacy Evaluation, the results obtained and assessment of the project impact.

6. Methodology

6.1 Dakar Legacy Evaluation

The Legacy Evaluation process was outlined in a document, the Legacy Evaluation Terms of Reference, issued in June 2019. The methodology that was adopted comprised the following activities:

1. Stakeholder engagement and interviews/meetings with a number of stakeholders with whom good relationships had already been established. Contact details were maintained to ensure good records were preserved with appropriate meeting notes, comments and recommendations for the future;
2. Continued web research and literature review on land administration, focused on research centres and organisations with experience of Africa in general and where relevant, in Senegal, and in particular related to the importance of property tax in Africa;
3. Continued meetings and discussions with the Airbus technical team and understanding data capture and the land parcelisation processes for the production of appropriate technical demonstrations;
4. Also of importance have been the previous contacts with DGID (and the support in this area provided by DFID) and discussions on the major projects on cadastre that are being considered by the Senegal Government.

The list of key stakeholders contacted during the main project and the Endline Evaluation was reviewed before the legacy visit with the intention of revisiting these contacts to elicit their current views. These contacts, as listed below, form the basis of the Legacy Evaluation and its findings. A column has been added to the table from the Legacy ToR in order to indicate their involvement in the Legacy Evaluation.

No	Organisation	Reasons	Confirmation of Involvement
1	DGID Management	DGID is main beneficiary for change detection	Continued acknowledgement of the benefits of change detection as a means of property data maintenance
2	DGID Cadastre Unit	Main instigator of the Land Information System and National Cadastre projects	Ongoing analysis of options for these major projects
3	ADM	Coordinator of World Bank MASP project	Continued interest in satellite technology as part of the development of municipalities
4	CETUD	For Rapid Bus transit project update For update of rail project	Not revisited for legacy evaluation. Although the concept of urban modelling is relevant to the impact assessment of transport schemes, the World Bank is currently more interested in economic change rather than spatial change

5	ANAT and, specifically, DTGC	Use of satellite data for mapping and other uses and update on views on data sharing via NSDI	Continued interest and awareness of potential in the wider economy. New National Spatial Plan and National Geomatics Plan all reference (in law for the former case) a requirement to adhere to spatial principles which should influence use of spatial imagery
6	Resilience Strategy committee members / Rockefeller 100 Cities Programme	For update on status on future options	Organisation no longer operating. New similar initiatives with similar objectives in existence. Plans reviewed through literature search
7	PSoE (and their software development partner, Idyal)	Update on valuation project	Continued cooperation and potential for collaboration in developing relevant software
8	World Bank	Active engagement in the sector in Senegal	Personal contact delayed due to postponement of Land Conference. Remote contacts only
9	Research Institutions e.g. ICTD and APTI	Evaluate experience in Senegal compared with other African Countries	Ongoing through email exchange
10	NAC	Local relevant experience	Potential significant involvement with utilities

The Legacy Evaluation visit to Dakar was conducted between 24th February and 28th February and was undertaken by Bob Owen, Airbus M&E Specialist, assisted by Graham Deane, Airbus International Business Development Manager.

6.2 Limitations to Methodology

The meetings and research provided valuable information and, on all occasions, confirmed significant interest. The main limitation has been in the amount of time that could be made available by stakeholders and organisations to discuss in greater detail the full implications of aspects of the project and its legacy; however, the team is certainly grateful for the valuable assistance that was given.

In some cases contact visits could not be completed and in the case of the World Bank a significant setback to discussions was caused by the cancellation of the World Bank Land & Poverty Conference in Washington (scheduled for 16-20 March, 2020) when Airbus was due to have important meetings with World Bank officials about, inter alia, the WB MASP programme and other potential imagery and change detection applications in Bank-funded projects

Where meetings were conducted in French (and in some cases the Dakar organisations had good English speakers), Airbus had the assistance of Airbus native French speakers

available. This certainly helped in eliciting information from the various stakeholders involved.

6.3 Legacy Evaluation Questions

The M&E questions that were considered to be important before full project commencement and, therefore, before significant in-country and project knowledge, were detailed in the M&E plan for the Dakar Change Project. This included reference to the Legacy Evaluation. Many of these specific questions were researched and answered in the Endline Evaluation Final Report. For clarity and completeness these questions are set out below. The objective of the Legacy Evaluation was to revisit these questions and to make further comments and edits, as appropriate. However, it was not the intention of the Legacy Evaluation to repeat the Endline study but to review the questions and provide updates, where relevant.

Relevance

1. Is the change detection system using satellite imagery still considered an improvement on the existing system as a base for calculating tax revenues based upon up-to-date details on land and property: Why/How?
2. Do stakeholders understand the importance of Earth Observation and can they identify other applications for it in Dakar?
3. Has the project remained worthwhile for Airbus in terms of income, public relations and business development?
4. What is the potential for increased revenue from the new methods being adopted? Is this potential reliant on other projects being implemented?
5. What progress has been made with developing the National Cadastre project in Senegal and has the concept of database maintenance, which is a key output from the change detection project, been incorporated?
6. What additional land administration projects have been identified and acted upon by Airbus, particularly in relation to change detection and property based revenue opportunities?

The assessment was to confirm whether the concept of relevance remains the same after 14 months following completion of the project. This is a key indicator of project legacy.

Effectiveness

1. How many staff have been trained to process imagery and carry out the fieldwork for the change data collection of parcels and buildings. And is this sufficient for the work required?
2. How much of the city is included in the parcel map? Is this more or less than what was planned?
3. Did the process effectively identify the changed parcels and buildings adequately (within QA requirements)?
4. Do citizens pay the tax, how much and is there any opposition? Why/Why Not?
5. What are the key barriers to being able to generate additional revenue and implement new city services?
6. The PSoE work will be completed by the time of this legacy evaluation. How will the

results of that study impact upon the objectives of the legacy evaluation, including willingness to pay?

The assessment was to confirm whether the concept of effectiveness remains the same after 14 months following completion of the project.

Efficiency

1. How long does it take to collect the property / dwelling data as opposed to the city authority's current methods of working?
2. Are field teams collecting property information at a rate as per original assumptions? What is the optimal way of structuring field data collection?
3. Is the service cost effective?
4. Has the city been mapped for land parcels by month six?

The assessment was to confirm whether the concept of efficiency remains the same after 14 months following completion of the project.

Impact

1. What is the potential for new jobs to be created for data collection of change detection?
2. Have/will citizens benefit and if so in what way?
3. What (early) indication is there that, in combination with other city level developments, an effective property tax system could be implemented which generates substantial revenue for the city?
4. Has the project generated interest or business elsewhere, for example in other city or national departments – what stage is this at?
5. Where there any unintended Impacts?
6. What other (unexpected) people have shown interest in monitoring urban change detection? What for?
7. To what extent has the concept and practical application of revenue collection been adopted by other countries (and by which ones) and how can the idea of change detection by satellite technology be introduced as an effective solution?
8. As the impact is being assessed just over one year after completion of the original project, success would be measured as confirmation of the level of planned uptake of the methodology.

As has been reported within the project, there are currently several initiatives on property based data collection and property revenues in Dakar but this work has not so far been translated into an operational project. So the measure of success would be confirmation by DGID that 1) a citywide property revenue system is planned (with an outline schedule) and 2) confirmation that a data maintenance regime will be incorporated into the plan.

The assessment was to confirm whether the impact remains the same after 14 months following completion of the project.

Sustainability

This section will be a particularly important component of the Legacy Evaluation

1. Is there a strategy/potential to roll out to all of Dakar and other cities in Senegal?
2. Has the city budget been set up to employ sufficient staff to continue the project methodology? What is the cost of doing so? What has happened after the UKSA funding ceased?
3. Does iteration by locals for parcel updates meet expectations?
4. Are there trainers available to carry out training (train the trainers approach)? How many of the people trained are still available? And projected in 6/12 months' time?
5. What other cities / countries / regions are most viable for roll out, e.g. in Africa, Asia, South America?
6. What concrete evidence is there of interest and practical steps being taken by the IFIs to introduce database maintenance into land administration projects?
7. What progress has been made in implementing the roadmap described in the final sustainability plan?

The assessment was to confirm whether IPP Project sustainability remains on-track after 10 months following completion of the project and what practical steps could lead to possible improvement.

What will be the counterfactual analysis?

The counterfactual situation (i.e. what would have happened in the absence of the IPP funded project) was carried out and reported on using a model developed within the CEA. Any new facts uncovered during the Legacy Evaluation will be reviewed for potential impacts on this CEA model. An important factor for review will be the parallel Paris School of Economics (PSoE) work, which is also being carried out with support from DGID.

6.4 Optional Second Country Legacy Evaluation

In addition to the main legacy focus on Dakar, and based on the target impact of generating interest in the methodology in new countries, the preparation for the Legacy Evaluation did consider the option of undertaking an assessment in a second target country. This was based on the possibility of a second country (where Airbus has already initiated discussions) taking some concrete steps towards implementing the urban change monitoring methodology; in which case a short M&E visit would be relevant in that country. The principal objective would be to illustrate the wider impact, relevance and sustainability of the change detection methods developed with co-funding by UKSA in a country not included in the initial project.

The candidates to be considered were Uganda, Kenya, Ghana and Sierra Leone as Airbus has had contacts with all of them in relation to property monitoring and data maintenance. However, although there are ongoing discussions in several of these, there has so far been insufficient progress in any country to warrant an M&E Evaluation exercise at this time.

The basis for initiating a visit would be the level of response by Government to the initial approach by Airbus and a review of any positive steps taken by the relevant target Ministry; with a clear policy statement about future property-based revenue generation being a minimum requirement. Unfortunately none of the opportunities currently under review have progressed sufficiently for a review to be worthwhile in early 2020. The most promising opportunities are in Uganda and it was originally expected that project definition would be completed in mid-2019; this is not now expected until mid-2020 (at the earliest) as the requirements have to pass through several government processes before being released.

7. Legacy Evaluation

In this section the main activities of the Legacy Evaluation are described. The mission held at the end of February 2020 involved meeting as many of the key stakeholders as possible and obtaining their current views on urban change monitoring and other potential applications of Earth Observation technology. Some of the data collection has been by email.

7.1 Engagement on Project Impacts of Revenues and Services

The IPP project focused on data and software applications with essentially two prospective markets/customers for change detection and its use in developing a city-wide property-based revenue generation system. The first was the ultimate beneficiary in the form of DGID who were and are the custodians of the property data. The second was thought to be the City authorities who, it was understood, had a responsibility for the collection of property taxation and who certainly have the responsibility of providing services paid in part by the tax collected. **The Legacy Evaluation confirmed the situation previously discussed at length in the Endline Evaluation that there is continued Government interest in the change monitoring.** However, at this time, Government is more focused on prioritising the collection of cadastral data which is complementary to, but separate from this change monitoring project. Briefly the legacy findings are as follows:

a) The Government Beneficiary - Direction Générale des Impôts et des Domaines

The main focus of DGID is currently in the launch and commencement of a National Cadastre to create and manage accurate data on the ownership of land – spatially and textually relating to ownerships. Whilst DGID continue to acknowledge and understand the importance of data maintenance, including via the change detection method in which they continue to show interest, their current emphasis is on the former and the funding for such a major task. Airbus has demonstrated the change detection methodology in the past (including an update workshop in July 2019) and, as a result of the Legacy visit, are able to provide to DGID a web application which allows them to view and query the data collected. Feedback from DGID will continue to be monitored and incorporated into future project planning activities by Airbus.

In terms of liaising with DGID about the national cadastre, Airbus continues to be in contact and discussion with DGID on this matter and awaits further developments. Airbus was also able to make DFID (through the DFID investment officer currently based in Dakar) and the UK Embassy aware of our interest and involvement with DGID so that they can monitor national developments.

b) Paris School of Economics and DGID

Although DGID is also responsible to maintaining the tax database it is known to be out of date; which is what the change detection system was designed to help resolve. In the Endline Evaluation it was reported that the Paris School of Economics (PSoE) had a project to review the existing tax base (in terms of what information exists and who currently pays) and to help create a valuation model and to collect relevant field data on properties in order to test it. Much further progress has been made in this area by PSoE and DGID as follows:

- A presentation was made on progress in June 2018 and February 2019 at the annual conferences held by the Africa Property Tax Initiative in Dakar and Kigali respectively;
- A valuation model was agreed between PSoE and DGID for testing; this captures up to 17 different attributes. Note this is significant decision as previous DGID valuation models, never fully implemented, required over 100 attributes;
- Software was developed by a local Senegalese software company called Idyal for use on an android mobile phone to collect these attributes in the field;
- Fieldwork is being carried out using this technology including the transfer of the field data collected to a central database hosted by DGID;
- This field data collection project covering around 200 enumeration districts is expected to continue until 2022.

However currently there is no means to update the data, i.e. in terms of monitoring change and also the spatial element of the field data collection and software is limited. PSoE and Idyal are therefore aware of the possibility of developing a Version 2 of their data collection software and have suggested that possibility to Airbus. This may have wider implications in terms of a spatial database and relationships to a national cadastre.

c) The City Authorities

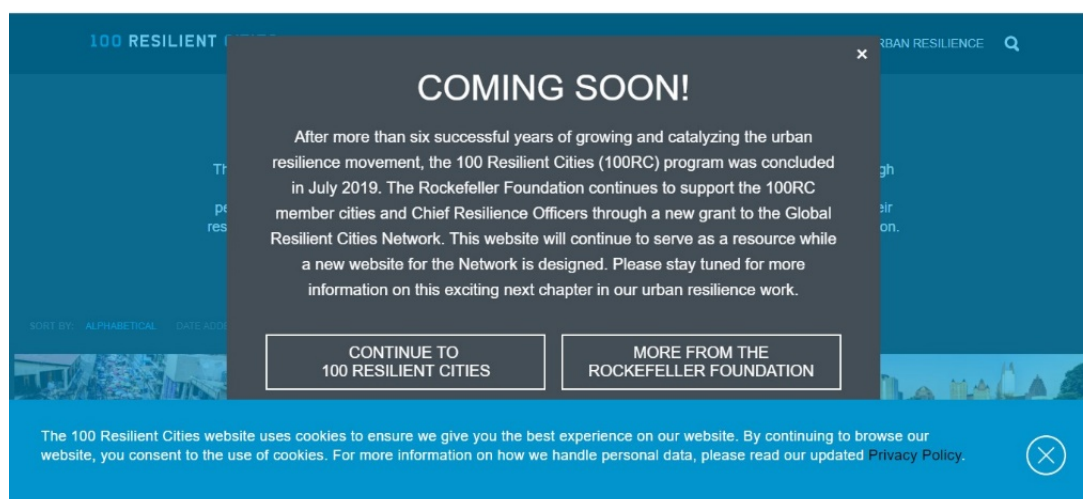
During the project and confirmed subsequently it is apparent that the City Authorities do not have a significant role in maintaining the property tax database, although they do have, as stated above, the responsibility of providing services. Change Detection can be used to update any database identifying those to whom these services should be provided.

In the Endline Evaluation the importance of these services was described using the “template” of a comprehensive list of city enhancements identified in the Resilience Strategy for Dakar produced by the “100 Resilient Cities” organisation pioneered by the Rockefeller Foundation and published in December 2016. The subtitle of the Dakar report is: “Preparing for a city that is clean, safe, energy efficient and poised for inclusive growth. This Resilient Cities organisation no longer exists, although the good work that it initiated is expected to be carried forward under the auspices of an organisation called the “Global Resilient Cities Network” <https://www.rockpa.org/project/global-resilient-cities-network/> whose objectives are stated as:

The new Global Resilient Cities Network (GRCN) emerges from the 100 Resilient Cities Program with a unique reach, strength and legacy to understand and support the challenges of the ever-growing urban society. GRCN is the city-led organization that will drive urban resilience action to protect vulnerable communities from climate change and other physical, social and economic urban adversities and challenges.

With support from The Rockefeller Foundation and other funding partners, the Network aims to continue supporting cities and their Chief Resilience Officers in future-proofing their communities and critical infrastructure.

The new GRCN started operations on September 1st, 2019 and is dedicating its first months to co-design its internal governance and programs, along with the rebranding of the organization to strengthen its essence and better represent the value of the expertise, knowledge and grass roots of the Network. A team led by former 100RC executives supports the Network with regional offices in London, Mexico City, New York, and Singapore. GRCN is comprised of 98 member cities in 40 countries of the former 100 Resilient Cities initiative and is expecting to welcome up to 10 new members in 2020.



Note also there is another similar network called the “**Global Platform for Sustainable Cities**” (<https://www.thegpsc.org/>), to date Airbus has had no contact with either of these networks.

7.2 Potential Users of Satellite Data in Senegal in Government

As indicated above, another focus of the Legacy Evaluation was to re-visit previous contacts made to confirm their continuing interest and assess any additional information and potential applications. It can be confirmed that although other potential users do have a lot of interest in satellite data, and there are quite a few potential applications, there are as yet no clear opportunities for concluding contracts in the immediate future, primarily due to availability of funding.

In addition to the primary stakeholders, these visits included the following:

a) Direction des Travaux Géographiques et Cartographiques (DTGC)

DTGC is the national topographic agency and has played a key role in the preparation of two important recent plans which have spatial implications for Senegal, including the potential for the use of satellite imagery. These are: **The National Spatial Plan**, published January 2020 and due to be enacted in law in April 2020, which will decree that all developments must comply with this plan; and, **The National Geomatics Plan (PNG)** which aims to provide Senegal with a geomatics development strategy and framework in order to make it a tool for sustainable development.

Other new and confirming information provided by the Director of DTGC was as follows:

- The national mapping which DTGC is responsible for is out of date and requires replacing. Although satellite imagery is an option, current work in this area by DTGC is to carry out the mapping update by aerial imagery in urban areas. This relates to the large scale of the map update and a photo resolution of 20cm which may be perceived as too large for even very high-resolution satellite imagery.
- Senegal Geoportal (<https://senegal.africageoportal.com/>) and Africa Portal (<https://www.africageoportal.com/pages/%20africa-living-atlas>). Both portals provide access to geospatial data and metadata about features such as locations, linear

features and boundaries. Satellite images can show land use, measure vegetation, and help plan for disasters. Geospatial data can include imagery, base maps, demographics and lifestyle, landscape, boundaries and places, transportation, earth observations, urban systems, oceans, and historical maps. It is therefore possible to combine all this with an organisations' own data to create maps, scenes, and apps and perform analysis. The Senegal portal data houses several ready-to-use datasets. Some are provided by the Agence Nationale de l'Aménagement du Territoire (ANAT) of Senegal; the Agence Nationale de la Statistique et de la Démographie (ANSD) of Senegal; the Africa Living Atlas; and, others by individuals and organisations focused on Africa. It is possible to combine this data with other data to create a broader and more detailed perspective. The Africa portal is similar (and contains the Senegal data) but contains Africa-wide data.

- A key dataset which is absent in Senegal is the accurate definition, both spatially and textually, of municipal boundaries. These are key datasets which determine the resources and services to be provided to communities and people within them; because there is no accurate delineation of these boundaries, the allocation of resources and local planning becomes problematic. DTGC has started to digitise these boundaries in a pilot exercise but as there are some 557 municipalities across Senegal it is a large task for which there is no current finance. Discussions took place about the option for using very high-resolution satellite imagery, including the forthcoming Airbus Pleiades Neo satellite imagery at 30cm resolution, which should be available later in 2020.
- The Director of DTGC is also Chairman of the Africa Region of the United Nations Global Geospatial Information Management (UN-GGIM) committee and, therefore, has contacts and influence in the geospatial community across Africa.
- In all of these activities and operations the issue of the importance of training and capacity building was described as crucial.

b) Agence de l'Informatique de l'Etat (ADIE)

Amongst the responsibilities of ADIE are the implementation of IT infrastructure policy of Senegal and “*developing a set of products and services to contribute to good governance by promoting an effective and efficient digital administration at the service of the citizen.*” ADIE is therefore involved in GeoSenegal <http://www.geosenegal.gouv.sn/> a geospatial portal providing awareness and access to geospatial data hosted on a website. This includes the national mapping and is a good initial step in the process of delivering spatial information.

ADIE also confirmed the importance of the many government and professional bodies who contribute to the “workings of government” that are involved in Digital Senegal. This includes, also, the importance of those matters which reach beyond technology and are a crucial foundation for effective decision-making and the operation of government. These include training, data coordination and data and information sharing. Two specific and key datasets were singled out: municipal boundaries (as also emphasised by DTGC above) and cadastral data. The latter was identified as a dataset which provides the base for other datasets to be built on, including the development of several business models. Above all there was an emphasis on coordination of effort about data and organisations and plans. It is this emphasis that comes into play in many of policies defined under the Plan Sénégal

Emergent (PSE), within which ADIE will have a crucial role to play, particularly in Digital Senegal 2025.

c) L'Agence de Développement Municipal (ADM)

ADM has an important role in the World Bank Municipal Agglomerations Support Programme (MASP) project. It acts as a coordinating body for the programme (see below) with responsibility for “*overall coordination and implementation of the operation [which] entails, [inter alia] providing technical leadership and coordination in the planning and implementation of activities*”. A key dataset is likely to be the municipal boundaries – see also under DTGC and ADIE. Access to the change detection web interface has been provided to ADM to allow more detailed access to the project data to find out if the technology and data therefrom can be of value for the MASP project. To date we await their responses.

- ADM also has other interests and project involvement with satellite imagery potential. These include:
 - Interest in and attendance at events organised for the Global Platform for Sustainable Cities which aims to build cities “*capable of offering a healthy and operational environment to the generations of today and tomorrow.*” See also the Global Resilient Cities Network (GRCN) above under City Authorities.
 - The further development and the allocation of funds for the Saint-Louis Coastal Protection Project (PPCS) funded by French Development Agency (AFD), for the construction of flood defences. However, it is likely that because the project is well advanced that any initial imagery requirements have been met but as with all projects monitoring for change is an important consideration.
 - Addressing Cities: ADM is involved in a project in 11 urban centres (Thiès, Louga, Diourbel, Kaolack, Ziguinchor, Tambacounda, Guédiawaye, Saint-Louis, Dakar, Pikine and Rufisque) to provide street and building address as a tool to help decision-making, improve local taxation and facilitate urban management actions for municipalities, concessionaires, central administration and citizens. A key requirement must be the identification, including changes over time, of the buildings and properties. As an adjunct to this it should be noted as a potential application that globally four billion people do not have an address, many of them in Africa, and one billion do not have a building identification; i.e. they do not exist as far as the authorities are concerned, because they do not have an address.
 - Lastly ADM is a dedicated user of GIS and is aware of the importance of data maintenance as evidenced by a statement by Mamadou Wade, secretary general of the Municipal Development Agency (ADM) who stressed, January 22, 2020, the need for the actors involved in the fight against floods to take ownership of the geographic information system (GIS) of risk areas and stated:

" A GIS has value only if it is maintained and updated regularly. I therefore invite the representatives of cities, decentralized state services and all the stakeholders concerned by the problem of flood control to take ownership of this tool, make it their own and update it regularly ".

d) The Emerging Senegal Plan (Plan Sénégal Emergent, PSE)

During the Legacy visit the importance of the PSE became more apparent and took greater prominence in discussion with government departments such as ADIE and ANAT / DGTC where their work was mentioned in the context of the Plan. Economic development is always at the forefront of government policy and the PSE has been developed so that:

“the Government will initiate the breaks which will make it possible to register Senegal on a new development trajectory. These ruptures will result through bold actions to sustainably raise growth potential, stimulate creativity and private initiative in order to satisfy the strong aspiration of the populations to well-being.”

This aspiration for well-being is expressed in a vision which is that of “A Senegal emerges in 2035 with a united society in a state of law”. The strategic directions that will guide the initiatives to take to translate this vision in actions and tangible results for the benefit of the population are based on three axes aimed at:

- *structural transformation of the economy through the consolidation of current drivers of growth and development of new sectors wealth, job, social inclusion and high capacity creators export and investment attraction. This axis is part of a more balanced development option, promotion of terroirs and clusters economic opportunities in order to stimulate the development potential on the whole territory;*
- *significant improvement in the living conditions of the populations, a fight more sustained against social inequalities while preserving the basis of resources and promoting the emergence of viable territories; and*
- *strengthening security, stability and governance, protection of rights and freedoms and the consolidation of the rule of law in order to create the best conditions for social peace and foster full development of potential.*

Part of the significance of this is in the adoption of the National Spatial Plan and the National Geomatics Plan, as mentioned above, but also in the different constituent plans and projects which make up the overall PSE. These include:

[Senegal Digital 2016 - 2025](#) - The “Digital Senegal 2025” strategy was developed based on the guidelines set by the PSE. It embodies Senegal’s ambition to maintain a position as an innovative leading country in Africa in the digital field. It is made up of four (4) priority axes:

- *Axis 1: Open and affordable access to digital networks and services*
- *Axis 2: A connected administration serving citizens and businesses*
- *Axis 3: The promotion of an innovative digital industry that creates value*
- *Axis 4: The diffusion of digital technology in priority economic sectors*

*These prerequisites and axes are articulated around the slogan “**digital for all and for all uses in 2025 in Senegal with a dynamic and innovative private sector in a high-performance ecosystem**”*

e) British Ambassador and DFID

During previous M&E visits a good relationship had been developed with the UK Embassy and particularly the Ambassador. For this legacy visit the Ambassador had changed. Airbus

was however fortunate that representatives were able to meet with the new Ambassador on another visit to Senegal late in 2019, not specifically related to the M&E of the IPP project, but in connection with developing a plan for the national cadastre.

During the Legacy visit, the Ambassador was unavailable but a meeting was possible with the Commercial Diplomacy Officer and the DFID Foreign Direct Investment Advisor for Senegal and Cote D'Ivoire, who is in post for two years from late 2019.

Both were very supportive and although the focus of the DFID Advisor is directed towards the encouragement of business / industrial development in Senegal, the land side was familiar as a main funding programme in other parts of Africa and one in which reviews for the future are being considered by DFID.

An additional DFID development is the future arrival of a DFID staff member to work on the impact of UK aid on SDGs in Senegal.

DFID and HM Embassy are keen to assist where they can and the discussion covered areas of Airbus expertise and suggestions for expanding our contact base, relevant introductions and general ways in which they felt we could expand our space profile in Senegal. This also included contacts within DFID, in particular, relevant contacts on a DFID tax programme which may have relevance to the Airbus project and potential relationships with other tax research organisations which are part-funded by DFID including PSoE, ICTD and APTI as previously mentioned, and also the London School of Economics (LSE).

f) World Bank and IFIs

The World Bank Land Expert (accompanied by a DFID advisor) visited Senegal during 2019 in order to prepare a Project Identification Document in relation to developing support for improved land tenure in rural areas. Airbus has been in contact with the WB Expert and was due to meet him in Washington during the 2020 Land and Poverty Conference in March. This event was unfortunately cancelled and a video conference has been proposed (but not yet implemented).

Based on the project identification visit the Proposed Project Development Objective is *“to strengthen the Government’s capacity for the implementation of its cadastre at a national level; and to improve the land use and property rights registration system in selected areas.”* This project, if implemented, is therefore in line with the project requirements identified in previous discussions with key stakeholders in DGID, and the Cadastre Unit in particular. It will be an important activity as it is clear that the capacity to implement and manage a national cadastre is not currently available in Senegal and therefore a major programme of capacity building is required. This activity will be fully complementary to the data capture and data maintenance activities being proposed by Airbus following completion of the IPP supported project. Airbus will therefore maintain a dialogue with the World Bank on this subject.

7.3 Private Sector and other users of Satellite Imagery

a) New Africa Consulting (NAC)

NAC was the local partner to Airbus for the Dakar Change IPP project. They provided the local GIS trainer, the trained data capture personnel, field data collection teams and office staff to support the project. Since the end of the project NAC has been carrying out work for

one of the telecoms utilities, collecting data on land and buildings to identify and confirm existing and potential new customers for the service provider. NAC are employing a large number of staff using mobile technology, with GPS, to collect the data in the field and are setting up regional offices for this purpose. The skills developed during the IPP project are certainly helping NAC with this endeavour.

Discussion took place concerning the Dakar Change web application developed by Airbus, the content of which NAC are familiar with as they helped to create it, and its possible use by the utilities for regular urban change monitoring. The current field data collection by NAC is only for a single point in time and as new properties / buildings are developed it quickly goes out of date. NAC will assess the web application with a view to demonstrating it and the satellite-based technology to the utilities. An immediate additional requirement might be the inclusion of the utility infrastructure together with other layers of local authority boundaries, general infrastructure, etc. in the web application. A process of requirements capture for monitoring urban change for utilities is currently underway. The aim is to provide a change monitoring service before the end of 2020.

b) Idyal Groupe

Idyal is a Senegalese software company who has been working with PSoE and DGID on the tax valuation project, partly supported by DFID, for approximately two years. They have developed software which is used on Android smart phones and enables the collection in the field of 17 different attributes of ID, address, building type, etc. This number can be added to by the client (i.e. DGID) themselves. From these attributes a relatively simple valuation model has been created from which property tax due can be calculated. The mobile software is multi-lingual with both French and English versions currently available.

The field teams do not make use of any detailed parcel geometry other than parcel information provided by DGID (not the cadastral section) and the accuracy and derivation of such geometry is not known.

It was stated the field teams will continue to be deployed in Dakar Region and it is likely that it will take until 2022 to complete the data collection in 200 cadastral “sections.”

This initial part of the software development as Version 1 has been sufficient to allow the field teams to collect data, to develop a data valuation model and from that to create a possible tax base. It is confirmed that only about 20% of the total possible tax is currently achieved and that they anticipate improvement on previous figures in test areas they are working in, achieved as a result of field teams actually visiting properties and obtaining information which identifies occupants and ensures that these occupants are aware of a credible system being put in place based upon real and accurate information.

The interest in a change detection system as expressed by Idyal, PSoE and via them to DGID, is that it would provide a GIS geographical element with the vital data maintenance element, and, they are keen to explore the possibilities of collaboration with Airbus to develop a Version 2 of the software which would include these functionalities.

c) Institut des Sciences de la Terre (IST) / Université Cheikh Anta DIOP (UCAD) de Dakar, Remote Sensing Department

The Director of the remote sensing laboratory at UCAD is engaged in a World Bank Agriculture project associated with food security using high resolution Sentinel data at 10 metre resolution.

The objective of the WB programme is to compute cereal production from agriculture parcels identified by GPS on the ground and by cereal type. Airbus was able to demonstrate the potential for greater clarity and accuracy and other features from very high-resolution imagery. Examples of other Airbus projects, including drought monitoring in Kenya, were discussed. One of the issues in Senegal is the very short growing season (planting to harvesting), indicating that the use of imaging radar during the rainy season may provide more observation points for yield assessment; Airbus will continue dialogue with the Director.

7.4 Airbus Activities – Promotion, Support and Technical Effort

a) Technical Application

The main technical output since project completion has been the development of a web application which allows a restricted list of users to access the data results from the project and interactively query the data in terms of the building layers of change and the associated attribute information of types of change, such as height differences, and to compare the satellite image data from different dates. This application has been provided to some of the potential users for their assessment and use, with requests for feedback to improve the application and a key request for how it could be used by their organisation. It is planned to provide this to these, although feedback results are not yet available:

- ADM – for possible use in accurately defining changes to land and property in concert with a definition of the municipal boundaries;
- NAC – for use by potential customers in the utility market to enable them to identify possible new customers based on the existence of new or expanded buildings in key areas. Possible further “mapping” to show utility infrastructure to establish a link between new customers and the existing infrastructure;
- DTGC – for possible assistance with the accurate definition of municipal boundaries and use of satellite data for map updating;
- DGID – for further enhancing awareness and knowledge of the technology as a means of updating their cadastral database as well as the original intention as a means of assisting in the management of tax revenue collection.

b) Space Day Conference

Airbus Defence and Space has organised (via the Madrid office) a Space Day that to be held on 28th April 2020 (now postponed until October 2020). The Provisional agenda and invitee list are a high profile one and is summarised as follows:

Format & Themes

- Selected format for the event:
- 1 day: 28.04.20
- 1 plenary session in the morning:
 - opening by Senegalese Officials,
 - Airbus presentations on its capabilities and applications, some users will talk about their use of space
 - Presentations from the Senegalese space ecosystem
- 5 booths sessions in the afternoon: Airbus and Islamic Development Bank.
 - Topics will be: Digital; Agriculture; Land Administration; Energy; Technology and Innovation These will be 1/2 hour sessions and people will rotate on the stands




Officials Invite list

- Ministry of Higher Education, Research and Innovation
- Ministry of Post, Telecom and Digital Economy
- Ministry of Fisheries
- Ministry of town planning
- The Minister of Agriculture
 - DAPSA direction of analysis of forecast of agricultural statistics
- Ministry of the Environment and Sustainable Development
 - Directorate of Water and Forests, Hunting and Soil Conservation (DEFCCS)
- Ministry of Economy, Finance and Planning
 - DGID Directorate General of Taxes and Domains
- Ministry of Industrial Development and SMI
 - Department of Mines and Geology

This high profile event will showcase, amongst other things, the Airbus experience in land administration and agriculture and, particularly, the importance of data maintenance. It is planned that some results from the Dakar Change IPP project will be presented at this meeting to as wide an audience as possible, including the Ministry of Finance and, of course, DGID. This event will be convened as soon as travel and meeting restrictions are relaxed and will be a major opportunity in the contact of the IPP project and its legacy.

c) Africa4Future

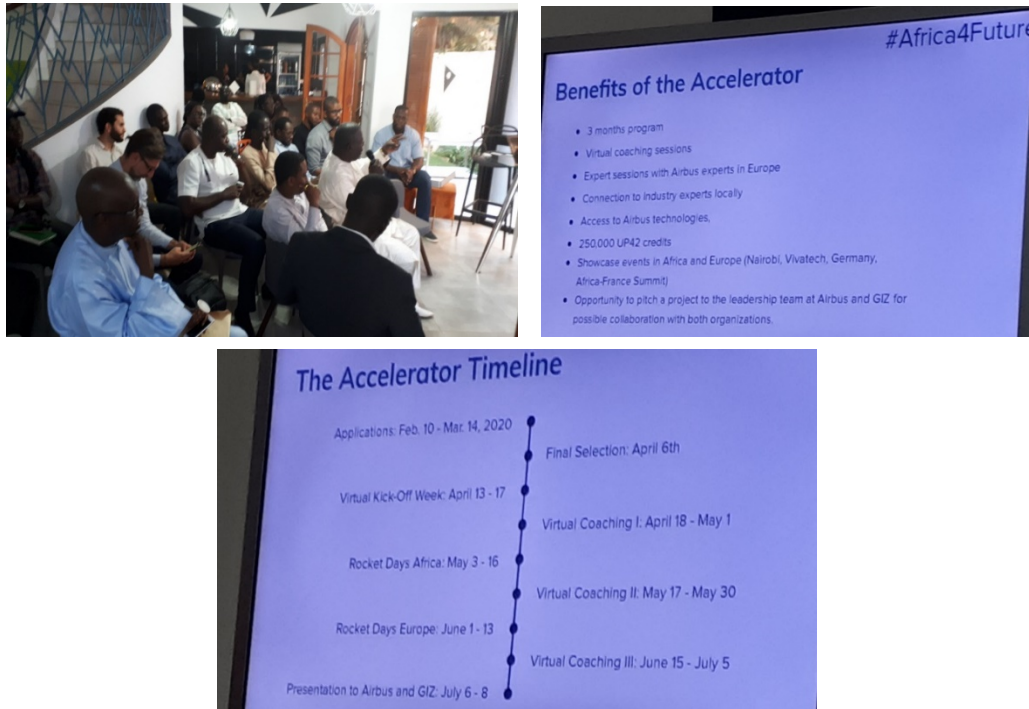
Africa4Future provides support to African companies interested in developing satellite use applications. It is a joint accelerator programme between Airbus' global aerospace accelerator, BizLab and Make-IT in Africa, a programme by GIZ, the German Agency for International Cooperation.


First launched in 2017, the Africa4Future initiative was created by Airbus BizLab with the objective to encourage and support entrepreneurship in Africa. Through Africa4future, Airbus seeks to build bridges between the aerospace industry and the different players in Africa.

For this third edition now being launched, the accelerator is open to African start-ups, service providers and software companies that are actively working on solutions in agriculture and infrastructure that are related to remote-sensing technology. This includes automation,

blockchain, artificial intelligence, data analytics, material composites, manufacturing and more. Infrastructure refers to transportation/logistics mapping, water monitoring, waste management, real estate, urban development and other related areas.

During the legacy visit an information seminar was held to present the facts of the programme and to encourage applications. This seminar is also planned to be held in Lagos, Nairobi, Cape Town and Casablanca, when conditions permit.





Africa 4 Future

The African Aerospace Accelerator

#Africa4Future






Calling all startups leveraging remote sensing to create value in agriculture and infrastructure.

Explore new business opportunities with Airbus & GIZ



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Deadline: March 14, 2020

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Implemented by

d) Airbus Africa Offices

A meeting held with the Airbus Defence and Space Africa Sales Director ensured a higher profile for the project and its awareness by Airbus Senior management and in the Airbus Africa offices in Cairo, South Africa, Algeria, Nigeria, and currently planned new offices in Kenya and Ethiopia.

7.5 Research

Research is never exhaustive. New sources of information are continually being uncovered and new projects and initiatives are identified and are starting. This section looks in brief at this research from a Senegal viewpoint and a global one. It builds upon previous research reported on in the Endline Evaluation Report. Some of the “research” is directly relevant to the potential for use of satellite imagery on projects and some is of a more general nature.

a) Senegal Government Agencies, Institutions and Plans

The following paragraphs describe some of the national plans and government bodies that have been set up and which have positive implications for the potential use of geospatial technology and satellite data. Much of the information was provided by ADIE and DTGC or as a result of discussions with them. An important overarching consideration in all the Government actions is the impact of the Emerging Plan for Senegal (PSE) and many references are made to this in a review of projects, plans and the objectives of different institutions and bodies.

- **The Senegal National Spatial Plan**

A National Spatial Plan has been produced by ANAT and published on 24 January 2020 with a new law which will be enacted in April 2020 which requires that any new investment must adhere to the spatial plan. The plan makes reference to and requires commitments to geodetic and cartographic considerations.

In addition, the National Geomatics Plan (PNG) aims to provide Senegal with a geomatics development strategy and framework in order to make it a tool for sustainable development. The PNG is a document which establishes the objectives, strategies and means targeted by the Senegalese authorities for the development of geomatics.

<http://www.geosenegal.gouv.sn/?-Le-PNG->

- **Project for Urban Master Plan of Dakar and Neighbouring Area for 2035** - published January 2016

This project, funded by the Japan International Cooperation Agency, is designed to prepare an urban development master plan for Dakar Region with a detailed plan for one selected area and to undertake the capacity development of the Department of Urbanisation and Architecture (DUA) and related ministries, organisations and local governments, strengthening their staff capabilities so that they will be able to manage urban development.

https://openjicareport.jica.go.jp/pdf/12250007_01.pdf

- **Government and professional Institutions**

This includes:

- **Association of Senegalese Mayors** (Association des Maires du Sénégal)

- **Senegalese Association of Geomatics Professionals (ASPG)** - <https://www.aspg-sn.org/>
- **The High Council of Local Authorities:** the High Council is a consultative assembly with 150 members whose mission is to study and give a reasoned opinion on the policies of decentralisation, land use planning and development. <https://www.sec.gouv.sn/institutions/le-haut-conseil-des-collectivites-territoriales>

b) Global Research and Projects

Relevant research and projects on a global and UK scale are numerous. The following are only a selection of those that exist. There will be many more where geospatial data and especially satellite imagery is also relevant. The particular relevance of the change detection project relates to the importance of data maintenance (of which tax is only one application) and the perception that this is often given little attention. All of these activities are relevant to the IPP Dakar Change Project, either as directly relating to the principal goals of urban change or in demonstrating the potential applications of EO data in an urban context.

- **APTI and ICTD** (<http://www.ictd.ac/network/apti/>)

No further direct and detailed contact was made with these organisations. However, it was noted that both continue to carry out significant research, produce papers on tax and engage in projects in Africa. One of these projects is the PSoE project with DGID referred to in this report. It is also noted that ATPI hold an annual conference - in 2018 held in Dakar and in 2019 in Kigali. At both conferences PSoE presented a paper on progress on their project with DGID – “Bringing Property Owners into the Tax Net: Avenues of Fiscal Capacity – Evidence from Dakar, Senegal”

<https://www.ictd.ac/wp-content/uploads/2018/05/2018-APTI-Conference-Programme.pdf>

Also note further research in Kenya and Senegal at a paper on “Property Tax in African Secondary Cities: Insights from the Cases of Kisumu (Kenya) and M’Bour (Senegal)

<https://www.ictd.ac/publication/property-tax-african-secondary-cities-kenya-senegal/>

Both ICTD and ATPI (indirectly) are part-funded by DFID

- **International Growth Centre** (<https://www.theigc.org/>)

The IGC directs a global network of world-leading researchers and in-country teams in Africa and South Asia and works closely with partner governments to generate high-quality research and policy advice on key growth challenges. Based at LSE and in partnership with the University of Oxford, the IGC is majority funded by the UK Department for International Development (DFID).

The immediate relevance of IGC to the change detection project is that IGC have recently completed a study in Kigali, Rwanda “Using Machine Learning and Remote Sensing to Value Property in Rwanda” January 2020

<https://www.theigc.org/publication/using-machine-learning-and-remote-sensing-to-value-property-in-rwanda/>

- **Africa-Europe Alliance: Four new financial guarantees worth €216 million signed under the EU External Investment Plan**

“The European Commission signed today four guarantee agreements worth €216 million that will help unlock €2 billion to invest in renewables, urban infrastructure and start-ups in Africa and the Neighbourhood. The guarantees were signed with the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the German KfW Group and the Spanish development cooperation agency, Agencia Española de Cooperación Internacional para el Desarrollo (AECID), at the 4th Strategic Board meeting of the External Investment Plan (EIP)” (EC press release 22January 2020).

Part of this programme is for Resilient City Development (RECIDE) and may help the resilient cities strategy discussed in Section 7.1 of this report. *“This €100 million guarantee agreement is signed with AECID, the Spanish development cooperation agency. It targets Sub-Saharan Africa and the EU Neighbourhood. It will help cities develop public-private partnerships and lower the risks for private investors involved in financing urban infrastructure, focusing on: energy efficiency, flood protection, public transport, water sanitation and solid waste treatment. The guarantee reassures lenders that they will recover at least some of their investment in the event of losses and lowers borrowing costs”.*

https://ec.europa.eu/commission/presscorner/detail/en/ip_20_96

- **Global Platform for Sustainable Cities (GPSC) and the EO4SD-Urban Project: Dakar City Report**

GPSC, sponsored by the World Bank, is providing selected cities with urban extent imagery to facilitate a finer-grained understanding of urban expansion. The GPSC knowledge product for Dakar also contains information related to the provision of geospatial products from the project “Earth Observation for Sustainable Development - Urban Applications” (EO4SD-Urban), which is part of a European Space Agency (ESA) supported programme that is co-ordinated by GAF Germany in collaboration with a consortium of Earth Observation service providers in Europe.

The overall aim of the EO4SD Urban project is to integrate the application of satellite data for urban development programmes being implemented by the IFIs or Multi-Lateral Development Banks (MDBs) with the developing countries. The programme specifically addressed the following:

- Urban and Peri-Urban Land Use/ Land Cover and Changes
- Settlement Extent and Imperviousness and Changes
- Urban Green Areas and Changes
- Flood Hazard and Risk Assessment

<https://www.thegpsc.org/knowledge-products/geospatial-data-and-indicators/eo4sd-urban-project-dakar-city-report>

7.6 Legacy Summary Using the OEDC DAC Criteria

The Endline Report of the Monitoring and Evaluation assessment was based upon the evaluation criteria developed in the M&E Plan, as determined by the OECD DAC five criteria. This assessment is herewith updated as a summary of the Legacy Evaluation in which the

results of the project set against these criteria of Effectiveness, Relevance, Efficiency, Impacts and Sustainability, as shown in the table below. Within this table the comments provide the summary answers and confirmation, as appropriate, to all of the questions raised in the Endline Report Under “Analysis & Findings for Process, Economic and Impact and Sustainability” and in the Legacy ToR.

DAC Criteria	Legacy Assessment
Effectiveness	<p>The Legacy assessment confirmed from many sources (Government bodies and the private sector) the importance of a satellite change detection system as an effective means of data maintenance for land parcels, feature mapping, a property database and, especially, as the foundation for an effective operational cadastral database.</p> <p>Whilst tax revenue collection is important for developing city services, and therefore monitoring changes to the database are equally important (and the continued existence of global research and pilot programmes into property tax substantiates this), some of the barriers to be overcome still exist in the form of the production of an accurate database to begin with and the politically sensitive nature of the subject.</p> <p>The positive action taken during the IPP project and continuing in Legacy has been to maintain contact with the primary stakeholder, Direction Générale des Impôts et des Domaines (DGID), and understand and contribute to the ambition of a National Cadastre and to also contribute to the DGID / PSoE (Paris School of Economics) pilot project of gathering property attributes for valuation purposes pursuant to the later (possible / probable) implementation of a valid property tax system.</p>
Relevance	<p>Change detection (or database maintenance) continues to be identified by all stakeholders as a key requirement. The meetings held with both government and private sector stakeholders further emphasised this by identifying, for example: new applications including the importance of monitoring changes to land and property within municipalities coupled with the use of satellite imagery to derive a municipal boundary map; the identification of properties and the changes thereof for an Agence de Développement Municipal (ADM) financed addressing project; for the improvement of the customer databases of utility companies; as a software enhancement to the DGID / PSoE pilot tax project; to improve topographical mapping; and, as a shared data resource for the Senegal IT Agency ADIE (Agence de l'Informatique de l'Etat).</p> <p>Evidence from Airbus experience across Africa and research on the topic, including DFID and World Bank funded projects, confirms that the use of this technology is relevant to many other countries and cities. This is also the background to two Airbus initiatives in 2020:</p> <ul style="list-style-type: none"> • The Africa4Future Airbus programme supporting SME's operating as start-up software and service companies in developing new

	<p>applications in infrastructure and agriculture, and:</p> <ul style="list-style-type: none"> • A Space Day Seminar / workshop planned in Dakar in April 2020 to which senior politicians and officials from Senegal government departments will be invited (now postponed to October 2020).
Efficiency	<p>No additional technical work was carried out after project completion in January 2019, although an important step was taken in the development of a web interface to enable users and interested parties to access an application demonstrating the project results. Feedback from stakeholders given the application is awaited. However, the indication from all stakeholders with whom the project was discussed is that the method could be a more efficient method of updating property information than field-only based methods.</p> <p>No update to the Cost Effective Analysis was undertaken as no new data was available. The Endline CEA confirmed positive results from the project.</p>
Impacts	<p>The project impacts were all achieved by January 2019 but, without the clear implementation of the technical solution pending acceptance by DGID, and, pending decisions on the greater priority of a National Cadastre, as stated elsewhere in this report. In terms of the use to which improved revenues could be allocated the strategy outlined in the Resilient Strategy is clearly still valid but financial resources will have to be accessed, in the short term, from other areas than property taxation. Relevant factors may be:</p> <ul style="list-style-type: none"> • the “replacement” to the 100 Resilient Strategies organisation in the form of the Global Resilient Cities Network, https://www.rockpa.org/project/global-resilient-cities-network/ • Another programme called the “Global Platform for Sustainable Cities” (https://www.thegpsc.org/) including a specific Dakar project, EO4SD-Urban Project: Dakar City Report, https://www.thegpsc.org/knowledge-products/geospatial-data-and-indicators/eo4sd-urban-project-dakar-city-report • The MASP Programme in which ADM plays a leading role which will rationalise the financial relationship between national and local governments <p>Finally research and contacts made in Dakar and elsewhere confirm that the change detection methodology has significant applications for other organisations in Senegal and elsewhere globally.</p>
Sustainability	<p>Sustainability has been “witnessed” in a number of ways relating to project and activities some of which are as follows:</p> <ul style="list-style-type: none"> • The promotional activities being undertaken by Airbus stated above under “Relevance;” • New Africa Consulting’s new utility customers who will be advised of the opportunities for using change detection to enhance their database of customers; • DGID in conjunction with PSoE and their software partner, Idyal,

	<p>may introduce a geospatial element to their data collection if Airbus collaboration with Idyal can be implemented;</p> <ul style="list-style-type: none"> • The clear indication from the leading Senegal geospatial organisations of ADIE and DTGC (Direction des Travaux Géographiques et Cartographiques) that cadastral data forms a base foundation dataset upon which many business developments and economic development is dependent; • The knowledge of the importance of geospatial data and the sharing of such data (as promoted by ADIE) is exemplified by the publication of the National Spatial Plan and the National Geomatics Plan; • Most important of all is the publication of the Plan for an Emerging Senegal (PSE). This is a strategy, which constitutes the benchmark for economic and social policy in the medium and long term, whereby Senegal has decided to adopt a new development model to accelerate its march towards emergence. Within this plan is a complementary plan of Senegal Digital 2016 – 2025 which “embodies Senegal's ambition to maintain a position as an innovative leading country in Africa in the digital field.” <p>https://www.sec.gouv.sn/dossiers/plan-s%C3%A9n%C3%A9gal-emergent-pse https://www.sec.gouv.sn/dossiers/s%C3%A9n%C3%A9gal-num%C3%A9rique-2016-2025</p>
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7.7 Sustainable Development Goals (SDG's)

The SDGs identified for this project were:

Goal 17.1: Strengthen domestic resource mobilisation, including through international support to developing countries to improve domestic capacity for tax and other revenue collection

The Dakar Change project has as its main objective the development of a means of maintaining a database of properties that can be used to generate revenue through property taxation. As such the aims of the project are fully in line with this SDG.

No change in the Legacy Evaluation period.

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable

This goal would be achieved through the additional revenues which should be generated from increased property tax collection to be used in providing better and more efficient services. This approach is contained within the strategy plans described in the Dakar Resilience Strategy.

This remains a key policy objective of the main stakeholder, DGID, and although there has been some continuing research in the period (with PSoE) a fully operational activity is not yet implemented.

Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

This goal would be achieved with the implementation of the change detection system resulting in better data maintenance about the ownership of land and property leading to the ability to build additional services and including better knowledge of properties and planning implications. With the wider use of satellite imagery to monitor developments, as envisaged by, for example, CETUD, sustainable economic growth will be supported by improved transport facilities.

No change in the Legacy Evaluation period.

Goal 3: Ensure healthy lives and promote well-being for all at all ages

Reference to this goal is also made through the provision of better services with the implementation of the strategies recommended by the Action Plans set out in the Dakar Resilience Strategy. Change detection has the additional advantage of allowing the relevant authorities to monitor building and development and, therefore, make assumptions about population change. Such data will inform decisions about service provisions on health and education, etc.

Note that to be effective and achieve the goals, change detection should be implemented within a structure of land administration, increased tax revenues and the ability to share data to best effect.

No change in the Legacy Evaluation period.

7.8 The Logical Framework (LogFrame)

The key evaluation tool adopted for the M&E was the LogFrame which provided an overview of the project's goal, activities and anticipated results grouped into the elements of Impacts, Outcomes and Outputs. The main evidence presented for these elements and repeated in this Legacy Evaluation covers three main areas of project work: (a) stakeholder engagement; (b) technical developments, training and field data collection; and, (c) Senegal and global interest in the project application and solutions. Against each of the goals were stated criteria and targets in which all of the major targets had been achieved.

The LogFrame is presented in a tabular form designed as an at-a-glance summary; in many cases it is necessary to provide more detailed explanations on the final achievements which cannot sensibly be contained within LogFrame template. This section therefore comprises two sub-sections with updates described, where applicable, as a result of the Legacy Evaluation:

- **The LogFrame narrative.** This describes the background and important factors affecting the assessment of the LogFrame. This examines and references where necessary the three areas stated above of stakeholder engagement, technical issues and application interest.
- **The LogFrame table.** This is an at-a-glance summary. It should be emphasised that to obtain a clear understanding of the project achievements the narrative is essential background reading. Note that the Indicators and Means of Verification were defined

prior to project commencement. The results do not always correspond to those statements but the Narrative (Section 10.1) and the LogFrame table provide clear information as to the Legacy of the project.

The LogFrame narrative

In this section of the Legacy Evaluation Report an analysis and description of any changes or updates to the main evidence as reported in the Endline Report is reviewed under those three headings in summary form, as follows:

(a) Main Stakeholder Engagement, (especially Direction Générale des Impôts et des Domaines - DGID)

During the project, as reported in the Endline Evaluation Report, it was stated that the focus of DGID's effort was the National Cadastre and not with the change detection application although the concept of data maintenance (via change detection) was accepted. This situation had not changed and was confirmed in meetings. A parallel project being carried out by the Paris School of Economics for a different department within DGID was still in operation which might, in the future, provide benefit to the question of tax revenues. That project continues with Airbus maintaining a watching brief and the possibility of specific collaboration at the technical level via PsoE and their software partner. The City Authority interest in change detection was, during the Endline, manifest in a resilient strategy plan. The plan is still valid but the organisation (100resilientcities.org) promoting the initiative has been subsumed into a new world initiative, the Global Resilient Cities Network.

(b) Technical developments, training and field data collection

The Airbus solution was completed during the main project period and no further technical work has been carried out in Senegal. However, a web-based application was developed to demonstrate the main elements of the solution. This allows interested potential users and, in particular, the key stakeholders (all of whom are referenced in this and the Endline Report) to access the application and to query the results on a parcel by parcel basis. The availability of this application has been advised to the stakeholders and feedback will be reviewed over the coming months.

The separate Cost-Effectiveness Analysis (CEA) produced for the Endline Report identified the potential cost savings that could be achieved where change is clearly identified using the satellite method rather than a field-based alternative of employing staff to constantly "sweep" the whole of Dakar looking for change. No revisions or refinements were considered to be necessary as a result of the Legacy visit.

(c) Senegal and global interest in the project application and solutions and satellite imagery

Significant interest continues to be shown by a number of stakeholders in the use of satellite imagery and the change detection solution. Some of these were new applications, which include: the changes to land and property within municipalities coupled with the use of satellite imagery to derive a municipal boundary map; the identification of properties and the changes thereof for an ADM financed addressing project; for the improvement of the customer databases of utility companies; as a software enhancement to the DGID / PSoE tax project; to improve topographical mapping for the Direction des Travaux Géographiques et Cartographiques (DTGC); as a potential input to a major World Bank Municipal Agglomeration Support Programme (MASP) where the L'Agence de Développement

Municipal (ADM) will play a leading role; and, as a shared data resource for the Senegal IT Agency of Agence de l'Informatique de l'Etat.

On a global scale since the Endline Report, a paper was delivered at the World Bank Land and Property Conference in Washington DC in March 2019 and a number of informal meetings took place with the RICS about tax and valuation, and the application of satellite technology.

8. Logical Framework Tables

(note that references in the text mainly refer to sections in the Endline Report and therefore are not usually relevant)

IMPACTS				
No.	SMART targets	Indicators	Means of Verification	Endline Result and Legacy Review
1	Evidence that property tax collection can be improved fivefold by 2019	Accurate assessment of potential property tax that could be collected and £ value of property taxes (actual and potential) collected annually	Results from sample areas; revenue calculations based on sample areas and algorithms	<p>During the course of the project the total potential land tax revenue that could be generated was indicated by DGID to be c €40m with around 10-15% actually collected.</p> <p>The Airbus / NAC analysis using the satellite imagery plus field work estimated the potential total revenue was €76m if an up-to-date database of land and property was maintained. Furthermore our research indicated that change to land and property affected 5% to 10% of the properties over a 12 month period. A further relevant statistic from PSoE (from a limited sample of households) indicated that less than 20% of known properties paid land tax.</p> <p>The conclusion is that given an up-to-date database generated and maintained using satellite imagery, and all other factors being in place in terms of administrative systems for revenue collection, that there is evidence that property tax collection can be improved fivefold.</p> <p>Target Achieved</p> <p><u>Legacy Review; no change, see also the narrative on DGID and PSoE</u></p>
2	Identification of how improved revenue collection could be used for enhanced planning, development and maintenance of service infrastructure in key	Prioritised list of city service enhancements	Letters from Mayor's office	<p>A prioritised list of City service Enhancement is provided in the Dakar Resilience Strategy Published December 2016 covering civic engagement, climate change readiness, sanitation, energy efficiency and transportation.</p> <p>Target Achieved – see https://www.100resilientcities.org/strategies/dakar/</p> <p><u>Legacy Review; new initiatives identified after suspension of 100 resilient cities programme, but funding remains an issue to be resolved</u></p>

	target areas, including e.g. water and drainage, citizen security; and maintenance of open spaces (to be confirmed with stakeholders)			
3	Projected increase in job opportunities and roles created in local government by up to 20% for property data maintenance and ongoing tax collection as well as service provision and infrastructure maintenance by 2019	<p>Number of projected jobs and roles created for project area</p> <p>Number of potential jobs identified for a city wide expansion</p>	City budget strategies	<p>DGID is responsible for mapping the property parcels (cadastre and land register) and then maintaining the database. This database is also used as the basis for the land tax roll. However there is evidence that there is no property data maintenance carried out currently so there are no staff employed on this task. As part of the Cost Effectiveness Analysis (CEA) Airbus has calculated the numbers of staff required to manage the satellite change detection programme as a total of 32 comprising managers, IT and field staff.</p> <p>No attempt has been made to estimate additional employment opportunities as a result of new projects consequent upon additional revenues (as indicated in the assumptions column of the logframe)</p> <p><u>Target Achieved – See CEA</u></p> <p><u>Legacy Review; no change</u></p>
4	At least five new cities with confirmed interest in similar projects by 2019	<p>Number of cities with (new or expanded) confirmed interest in projects</p> <p>Value (in £) of each project for Airbus</p>	Project contracts identified, budgets and Airbus financial records	<p>Airbus has had contacts, discussed with and received verbal interest from a number of cities. Potential revenues for three of these cities was developed and shown in the CEA.</p> <p><u>Target Achieved but no firm contracts so far obtained</u></p> <p><u>Legacy Review; no firm contracts obtained but one new contract is now anticipated and initiatives are moving forward in two others.</u></p>

OUTCOMES

No	SMART targets	Indicators	Means of Verification	Endline results and Legacy Review
1	<p>Increase and improve database of the existing properties in the tax system from “15%“ of real life properties to 100% in five areas</p>	<p>Percentage of real life properties in database in five selected areas.</p> <p>Indicator changed to: the number of property parcels where change is detected</p>	<p>New database verified by field work reports</p>	<p>No accurate and complete database exists. A meaningful measure of change is the number of parcels identified by the project from satellite imagery (baseline) and then the number of property parcels identified as changed using the software developed in the project – measured at mid-point and end point.</p> <p>Overview results were carried out for Yoff – near the old Dakar airport where three levels of change were analysed:</p> <ul style="list-style-type: none"> • Yoff growth area Jan-Sept 2017 with 155 changes from total of 918 (17%) • Yoff growth area Sept 2017 – April 2018 with 121 changes from 918 parcels - 13% • Yoff stable area Jan-Sept 2017 – with 45 changes from 1370 parcels - 3% <p><u>Target Achieved See Annex C.</u></p> <p><u>Legacy Review; no change, data can now be viewed online by key stakeholders</u></p>
2	<p>Implemented methodology for parcel capture enables at least 95% of parcels to be mapped from image interpretation when checked in the field; (Key Performance Indicator (KPI) 1)</p>	<p>Percentage of parcels correctly mapped from satellite image interpretation compared to field checks</p>	<p>Assessment of field data</p>	<p>This indicator assesses the effectiveness of the change detection software and the field work based quality assurance of the results. To achieve this Airbus digitised approximately 90,000 valid parcels in Dakar from the satellite imagery. Field checking was carried out and comparisons made. Note that the initial field work identified some areas for refinement of the software which was carried out. In addition QA checks were introduced into the software analysis process which included gross checks to be carried out by displaying 3D images of the satellite analysis results.</p> <p>The checks carried out on parcel mapping were designed to ensure consistency between operators. In this context the target performance for image interpretation was achieved.</p> <p><u>Target Achieved See Annex C.</u></p> <p><u>Legacy Review; no change, data can now be viewed online by key</u></p>

				<u>stakeholders</u>
3	Improved efficiency of property change identification, as evidenced by a reduction in the time needed per square kilometre by 80% (i.e. change detection done in 20% of current time)	Time needed for property identification per square kilometre using imagery and software, compared to time needed for field data collection and / or as carried out previously	Operational reports, compared to estimates of current time	<p>The baseline figure for current DGID field processes for maintaining the database of land and property is zero because there are no current methods</p> <p>The CEA shows a requirement for 32 field staff using the satellite method as opposed to 61 for the field method to cover the City. Note that the figures quoted are for the City of Dakar rather than on a per square km basis as it is not practical to calculate such a figure</p> <p><u>Target Achieved - See CEA</u></p> <p><u>Legacy Review; possible use of property change data now being investigated by utilities</u></p>
4	Implemented methodology for building change detection captures building change in two dimensions and three dimensions with no more than 5% error rate (commission or omission) (KPI 2 and KPI 3)	Percentage of buildings incorrectly allocated, when satellite image interpretation is compared to field checks	Assessment of field data	<p>Final figures have been computed for several test areas based on both field observations and use of a photogrammetric viewer to examine the imagery in 3D. These figures show that the errors of omission (that is of change as detected by the satellite image analysis when compared to the field verification) are significantly less, at 3%, than the expected 5% error rate. But errors of commission (that is identified change which had not actually occurred), at 9%, are slightly higher than expected. However, the impact of this is that slightly more properties are visited on the ground for field checking, but there will be no new information to collect.</p> <p><u>Target Achieved – See Annex C.</u></p> <p><u>Legacy Review; no change</u></p>
5	Enhanced local capacity to use analytical tool for targeted field data collection by project close, as evidenced by local partner completing 3rd iteration using imagery and software	Percentage of buildings incorrectly allocated in 3rd iteration	Assessment of field data from third iteration	<p>During the progress of the project it became clear that in terms of staff time and efficient operation of the change monitoring system it was more efficient to provide the local partner, New Africa Consulting, with the finished software analysis results. This was instead of the previous plan of NAC receiving the satellite data height products (DTM and DSM) and carrying out the analysis. To implement this new system an interface application was developed to allow NAC to define geographical areas for analysis and the finished change detection analysis would be downloaded by NAC. Thus allowing NAC to concentrate and carry out the field work.</p>

	with minimum supervision, with no more than a 5% error rate (KPI 4)			<p><u>Target Achieved – using new technical method</u></p> <p><u>Legacy Review; local partner is using the skills developed in the project to collect field data on behalf of a telecoms utility</u></p>
6	Relevant city authorities fully conversant and knowledgeable of the processes and systems being implemented, as demonstrated by key government stakeholders reaching an average score of 70% (on a predefined capacity matrix or similar knowledge measurement tool / technique)	Capacity scores	Capacity surveys of key government stakeholders	<p>No formal capacity survey was carried out. However in the meetings and contacts made it is possible, based on the remit and responsibilities of the stakeholders interviewed with regard to satellite imagery and geospatial data, to make assumptions of readiness and technical ability to engage with change detection techniques and satellite imagery.</p> <p><u>Target Not Achieved but confirmation gained of key stakeholders’ readiness to adopt the change detection technology on basis of their key departmental responsibilities. It is also known that DGID has the relevant geospatial data handling skill sets.</u></p> <p><u>Legacy Review; no change, but confirmed acknowledgement of the importance of data maintenance</u></p>
7	City authorities decide to upscale mapping to entire city of Dakar by 2019	Percentage of city mapped by satellite data for tax purposes	Letter from head of relevant city department	<p>Airbus, as part of this IPP, mapped (from a parcel viewpoint) a major part of the Dakar project area. In addition to note that Dakar mapping is now considered part of the planned National Cadastre activities to be managed by DGID in which different technologies will be proposed for data capture for Dakar and Senegal, including the use of satellite imagery and drones.</p> <p><u>Target Not Now Relevant</u></p> <p><u>Legacy Review; no change</u></p>
8	City of Dakar has satellite data that can be applied to other problems (qualitative)	Descriptive examples of other problems which the city is (or is considering) using satellite data for	Letters, interview transcripts or survey notes from government officials	<p>Continued interest was shown during all meetings of the M&E visits with verbal requests and by email for further engagement and specific change analysis</p> <p><u>Target Achieved</u></p> <p><u>Legacy Review; no change– web application available to assess the data &</u></p>

				<u>confirmation of interest</u>
9	Strengthened partnership between UK and three developing countries (Senegal, Ghana and Ivory Coast) by December 2018	Number of countries	MOUs/letters of support from relevant governments to Airbus	<p><u>Target Partially Achieved - strengthened partnership but no specific MOU's signed, etc. However this is an ongoing activity of Airbus Business Development personnel.</u></p> <p><u>Legacy Review: – no new MOU's signed but positive feedback from Senegal, as outlined in this report, and from Uganda and Ivory Coast, so far</u></p>
10	Developing countries drive demand for space expertise	Value of export for Airbus DS from previous year (£/year); Forecast value of export opportunity for grantees at 2020 (£/year)	Airbus self-reported financials	<p>This is a developing activity and it is anticipated that the first results will be achieved during 2019.</p> <p><u>Target Partially Achieved - with ongoing activities through next 12 months</u></p> <p><u>Legacy Review: – no change but Airbus promotional activity in place including SPACE DAY seminar in Dakar in April 2020 (now delayed due to travel restrictions)</u></p>
11	Methodology demonstrated to at least five cities for future similar projects with Airbus	Number of cities approached/in discussion with Airbus	Emails, meeting minutes signed MOU to explore projects	<p>In addition to presentations in Washington and London at major land, property and geospatial conferences, the following approaches and progress has been made</p> <p>Addis Ababa - Ethiopian Space Science and Technology Institute</p> <p>Kakamega (Kenya) - local county council (several others also met at Governors' conference)</p> <p>Uganda – Ministry of Land, Housing and Urban Development visited October / start November</p> <p><u>Target Partially Completed – no MOU's and only three cities demonstrated to but others are in the pipeline.</u></p> <p><u>Legacy Review; results now presented to AfricaGIS, 2019, in Kigali, Rwanda and also to Freetown, Sierra Leone.</u></p>

OUTPUTS				
No	SMART targets	Indicators	Means of Verification	Endline Result and Legacy Review
1	One map of parcels produced by end July 2017 for project areas	Number of baseline maps produced	Existence of a physical map, and processes for generating map	Maps of 12 pilot areas of cadastral parcels have now been created. Information on this available, a summary of which is shown in Annex C. The relevant technical report will provide greater detail. One Baseline map - Completed Sept 2017 <u>Target Achieved</u> <u>Legacy Review; no change</u>
2	Two change maps produced with properties flagged that have changed from 1st mapping by end Jan 2018 and end July 2018.	Number of change maps produced	Existence of a physical map, and processes for generating map	See previous Midline and Milestone Reports- Completed Sept 2017 <u>Target Achieved</u> <u>Legacy Review; no change</u>
3	Evaluation tool developed for change detection and property characteristics tax assessment	Tool produced	Existence of tool	See Milestone 5: Change Detection Process Development 6th September 2017. Software substantially completed in Sept 2017 with enhancements now complete <u>Target Achieved</u> <u>Legacy Review; results available via online application that can be queried by the principal stakeholders</u>
4	At least four workshops / training sessions attended by four technical operators and IT staff for reliable field data collection and operational technical maintenance	Number of workshops held; number of attendees	Workshop/training records	In practice the training sessions have been attended by NAC staff who now have the relevant skills to undertake change analysis and the field data collection needed to maintain the database. These skills could, however, be transferred to DGID at a suitable time based on our 'train the trainer' approach. <u>Target not fully achieved - but not now relevant due to DGID priority interest in National Cadastre</u> <u>Legacy Review; no change</u>

5	Two workshops/training sessions attended by at least 20 members of data collection field teams	Number of workshops held, number of attendees	Workshop/training records	<p>Training of 14 NAC staff has taken place in two workshops – Milestone reports Number 3 (dated 28th July 2107) and Number 4 (dated 11th September 2017) provide detailed information as does the Knowledge Transfer (Milestone 9) report of 15th November</p> <p>Target Achieved</p> <p><u>Legacy Review; NAC now have a contract for field data capture on behalf of Orange Senegal</u></p>
6	Three knowledge sharing products developed for city departments, including one roadmap for nationwide implementation, which communicates technical knowledge, processes and systems, and, opportunities to be realised by the main relevant city authorities and two other city departments	Number of knowledge sharing products produced and shared with main revenue and cadastral departments and two other relevant departments (products to consist of information sheets, presentations and press releases)	Existence of knowledge sharing documents, and records of emails, meetings, workshops etc. where documents are shared/discussed	<p>For information on contacts and who the project has been presented to see Section 10.1 and Annex A.</p> <p>A first slide set of knowledge sharing products produced for AfricaGIS November 2017 and second slide set produced for WB conference March 2018. These have been improved during the final period of the project to include a final slide set (used at the project workshop in Dakar on 24thOctober), a short overview video and a project case study document. These are available in French and English.</p> <p>Target Achieved</p> <p><u>Legacy Review; web application produced for distribution to stakeholders. Summary results were presented at AfricaGIS in Kigali, Rwanda in November 2019</u></p>
7	One knowledge sharing product developed for wider industry, which communicate technical knowledge, processes and systems, and, opportunities to be	Number of knowledge sharing products produced and shared with wider industry stakeholders (outside Senegalese Gov't)	Existence of knowledge sharing documents, and records of emails, meetings, workshops etc. where documents are	<p>Knowledge sharing products provided in terms of presentations and papers to the wider industry to Africa GIS - Ethiopia (March 2018), WB Washington (March 2018), Kenya Governors Devolution Conference (April 2018), GeoBusiness Conference UK (May 2018). A paper on the CEA has also been accepted for the WB March 2019 conference.</p> <p>Target Achieved</p>

	realised	Product to consist of a case study brochure and press releases	shared/discussed	<u>Legacy Review; web application produced for distribution to stakeholders</u>
8	20 cities identified for next round of project growth	Number of cities identified in a potential roll-out/business development plan	Existence of a list/proposal of cities for future roll out	A number of cities have been identified where population growth is considerable and which may be candidates for the change detection software application. Target Achieved <u>Legacy Review; ongoing (active discussions in two more cities)</u>
9	One Public awareness plan developed and implemented	Number of public awareness plans developed and delivered	Existence of an awareness plan	Given the sensitive nature of ‘property value information’ together with the whole notion of property taxation and revenue generation, this does not seem to be the time for a public awareness raising activity for the general public. Pending a decision on full implementation in Dakar, and Senegal as a whole, which is currently high on the Government’s agenda (together with full implementation of a national cadastre), we do not now propose to have a public awareness campaign within the IPP project. The materials for such public awareness-raising can, however, easily be prepared from existing project documentation at the appropriate time. Target Partially Achieved <u>Legacy Review; no change</u>

9. Review of Actions Taken as a Result of the Endline Evaluation Report

9.1 Review of Endline Future Actions

The Endline Report set out a number of actions to be carried out after project completion. These are shown below and against each is a comment on the action that was taken during the Legacy period (January 2019 to February 2020). In many cases details of these actions are described in the body of this Legacy Evaluation Report and so the appropriate references are made. The Endline Report actions are shown in bold Italics.

1. DGID – recommendations for future contacts

As discussed in Section 7.1, Airbus continues to make regular contact with the principal stakeholder, DGID, with several meetings held in Dakar. These included a technical workshop in July 2019 which was used to show the IPP Change Project results to an audience invited by the new Director of Cadastre (formerly one of the deputy directors). The change results were presented alongside a live demonstration of the operational cadastral software currently being used in Mauritius.

2. Continue contact with PSoE and monitor their progress as well as being aware of the potential for partnership on other projects

The research programme being undertaken by the Paris School of Economics (PSoE) has shared results with the Airbus team and continues to undertake research related to property tax payments and data collection for property tax calculation. A visit was made during the Legacy Evaluation to Idyal, a small Senegalese software company working with PSoE and with DGID to prepare field data collection software as a tablet application. Future contacts will be made with Idyal to discuss how a Version 2 of their software could link with the change detection process.

3. Write a short paper on maintaining a database and the holistic use of such a database emphasising its potential in the area of land administration. Whilst this report has set out the main benefits, many other benefits can be explained; these could include uses such as in developing a system for planning applications, land use and building controls

A paper has not yet been prepared specifically on this topic. However a written paper and presentation, entitled 'Cost-Effectiveness Analysis of a Satellite-Based Approach to Maintaining a Property Database,' was delivered to the 2019 World Bank Land and Poverty Conference in March 2019. This did present the IPP Dakar Change Project results and stressed the importance of data maintenance. Some key elements of this WB conference presentation were also presented at AfricaGIS in Kigali, Rwanda, in November 2019. These documents are in the public domain and are accessed through the conference proceedings of both conferences.

4. Review ATPI and ICTD literature and especially the ICTD Training Manual referenced above and comment on where technical input could help

Contacts have been established with both organisations, as presented in Section 7.5. This has led to some discussions on the possible use of satellite imagery to assist in ongoing projects in Sierra Leone and Uganda, but these discussions have not yet yielded formal business opportunities.

5. Contact DFID and other funders and further contact with APTI, ICTD, International Growth Centre and 100 Resilient Cities organisation

Contacts have been made with DFID through attending some workshops of the LEGEND programme (Land: Enhancing Governance for Economic Development (LEGEND)) and with the DFID Foreign Direct Investment Advisor in Dakar, who will, in turn, inform relevant advisors in the DFID structure. The Resilient Cities organisation no longer exists and has been replaced by the Global Resilient Cities Network (GRCN), from late 2019. This organisation will be on the contact list for future engagement. APTI and ICTD will also continue to be contacted in the future.

6. Continue contact with World Bank, particularly on MASP, and the Senegal stakeholders, especially ADM

See above in Section 6.2. Actual meeting with World Bank has been curtailed because of the cancellation of the Land and Poverty Conference which was due to take place in March. Contacts by email are being pursued.

In 2019 the WB conducted a project identification mission in Senegal, accompanied by a specialist from DFID. This I designed to provide assistance with rural cadastre, particularly in capacity building and strengthening given that the relevant authorities do not have direct experience of managing a cadastre or sufficient trained staff to provide the support services to citizens. The identified project is now going through the financing process. It is hoped that future discussions will enable the concept of data maintenance and change monitoring to be included in this process.

7. Write overview of the solution and how it could be implemented in different scenarios

This activity has not so far been undertaken. To date the enquiries have been made from Sierra Leone, Uganda and Nigeria and initial responses have been made to try and identify a suitable solution in each case, based on an understanding of specific requirements.

It is still planned to produce an overview of the change monitoring methodology as part of the marketing approach in different countries.

8. Continue to look at international conferencing opportunities including e.g. papers in magazines. An offer to publish in the RICS Land Journal has already been made and an abstract submitted to the World Bank 2019 Land and Property Conference on CEA

Two opportunities have been followed up, as indicated in bullet 3, above. Additional opportunities, such as the one with RICS, will be followed up during 2020. The intention would be to include feedback on results analysis carried out by DGID; the results of their analysis are still awaited at the time of writing.

9. Continue contact with the stakeholders who expressed significant interest in the project and the use of satellite imagery, chief of which are CETUD, ADM and DTGC

Visits to these contacts were carried out during the Legacy Evaluation, including the State Informatics Agency, ADIE. CETUD were not visited but they are known to have contacted DGID about access to information on properties agency to their principal route ways. All these agencies have an ongoing requirement for EO data and will remain a point of contact for possible urban change monitoring.

10. Identify and target countries for implementing the technology in other key cities

In addition to selecting countries where Airbus has strong local partners, through its established data re-seller network, careful watch is made of developments in international research and new international programmes. This is discussed under Research, in Section 7.5, and, especially, the references to projects being carried out by Africa-Europe Alliance, including four new financial guarantees worth €216 million signed under the EU External Investment Plan, the Global Platform for Sustainable Cities and the EO4SD-Urban Project (which demonstrates the use of EO data in urban areas). So far the focus has been on Africa, primarily to avoid spreading resources too thinly; other countries will be reviewed in the future.

9.2 Future Actions (beyond the Legacy Evaluation)

During the period between the Project Endline and Legacy Evaluations progress has been maintained. It is also the intention that developments will continue in the next months, subject to lifting the international travel restrictions that started in March 2020.

The key future activities will include:

1. Maintaining regular contact with DGID to discuss national cadastre and/or property tax goals for the future;
2. Continue contact with the stakeholders who expressed significant interest in the project and the use of satellite imagery, chief of which are ADIE, ADM and DTGC;
3. Continue to work with relevant international and national organisations to develop a data maintenance culture in the sector;
4. Continue contact with the World Bank, DFID and other DFIs in relation to the process of urban change monitoring;
5. Continue to review ATPI and ICTD literature and identify where urban change monitoring could help;
6. Write an updated overview of the solution as part of the marketing process;
7. Continue to look at international conferencing opportunities including e.g. papers in magazines;
8. Identify and target additional countries where property taxation and data maintenance are key issues for future development in line with SDGs.

10. Conclusion

10.1 Assessment of likelihood of achieving further impacts

The IPP project was conceived as a technical solution to the issue of change management or detection and keeping a property database fully up-to-date so that it can be used as a reliable and fair means of calculating property tax revenues, with direct benefits to citizens in supporting services. The project was also widened to examine sustainability and opportunities to extend the technology into other domains and to other applications in Senegal and globally.

The overall review of the project has been carried out through the creation of a LogFrame, a method of assessing and reviewing the project's goal, activities and anticipated results. This review was completed at the end of the project (Endline Evaluation, January 2019) and has been further reviewed in this Legacy Evaluation, as set out in Section 8 of this current report.

Against each of the targets, grouped under the headings of Impacts, Outcomes and Outputs, has been inserted a statement as to what has changed during the year following the Endline Evaluation. At Endline, all of the major targets had been achieved, an overview of which is as follows;

- the software technical solution had been created, successfully trialled and operated by trained local partner staff;
- quality assured data, digital maps, identification of land parcels and a simplistic (as requested by DGID) valuation model were successfully produced and an estimated potential revenue take for Dakar calculated;
- stakeholders with an interest in the use of satellite imagery had been contacted in Dakar and globally and Airbus had engaged in ongoing discussions with them. Many of these were borne out of presentations at international conferences and public awareness events;
- the proposed new method using the change detection satellite-based solution has proved in the CEA to be a more efficient method of operations compared to other possible methods, noting also that no data maintenance is currently undertaken by DGID; and, finally
- the potential for increased tax does exist and would be of great benefit in Dakar (and Africa) to be used for improving local authority services to citizens.

As written in the Endline Report, *“The relationship between change management and tax revenue is important to understand. DGID, the main beneficiary, fully understands the implications of having an up-to-date database (as do other stakeholders) but have prioritised the requirements of implementing a National Cadastre, with survey accuracies well in excess of the requirements of any tax applications. The ongoing PSoE project which is consulting on a modernised tax management system may have implications and find a way through the impasse by emphasising or explaining relationships between cadastral and tax requirements (as will any ongoing discussion by Airbus with DGID, post IPP project).”*

As a result of the Legacy Evaluation, it was found that circumstances have not significantly changed this statement. Although some personnel changes have taken place and some

reorganisation at ministry level, the fundamental requirements of PSE (Plan Sénégal Emergent) have not changed and both the National Cadastre and property tax reform remain high on the agenda although both of these, along with many activities in Senegal in 2019 did not move significantly forward; significant government reorganisation was frequently noted by stakeholders as a contributor to this.

The key to the implementation of the change detection system requires both acceptance of its benefits by the main Dakar beneficiary, DGID, and the means to pay for a service. As stated at many meetings with senior officials they have acknowledged the benefits but the difficulty is translating that into action in the face of their other priorities and the requirement for funding. Airbus has therefore continued a number of activities in the 12-month legacy period, all of which have achieved at least partial success. These can be summarised in the following table.

Identified Endline Activity	Legacy Evaluation Update	Likelihood of Success
<p>Airbus will continue to liaise with DGID and to arrange meetings with influential and internationally respected UK organisations in the land and tax domain in order to demonstrate the importance of the monitoring strategy. This could include RICS and HM Land Registry with whom Airbus has good relationships. In particular RICS have been very supportive to Airbus in recent land, valuation and tax investigations by prospective Airbus clients emphasising the importance of international standards and “Fitness for Purposes” methods.</p>	<p>This has been continued through meetings with DGID at regular intervals throughout the year. In addition a technical workshop was held in July 2019 with participants invited by the new Director of Cadastre, including participants from other relevant stakeholders ADIE, DTGC, and ADM.</p> <p>Interaction with RICS and HMLR has also been continued in order to ensure that ‘best practice’ processes are presented where applicable.</p>	<p>The potential success is dependent upon securing sources of funding. Contacts with several DFIs are continuing.</p>
<p>Continued liaison with PSoE on their project - to review progress and their comments on the apparent and perceived conflicts between tax and cadastral requirements. Recent contact with APTI via Management Committee Member, Mr Paul Fish, who is acting as a valuation consultant on the project will also help.</p>	<p>Contact maintained with PSoE in order to review their research progress. Local software partner is a potential partner for developing operational property tax field data collection software. Preliminary discussions have taken place</p>	<p>Use of a local software developer with a tablet-based data collection application will be useful for any future operational activity and an essential component of data maintenance.</p>

<p>Preparation of brief documents explaining how the change detection system can be deployed and used in different land administration situations and drawing attention to different requirements for tax and cadastre. This to include, using the CEA data, the opportunity cost of doing nothing in terms of revenue collection.</p>	<p>This was established through the presentation of a paper at the World Bank Land and Poverty meeting in March 2019 which focused on the project CEA.</p> <p>The main conclusions were also presented at the AfricaGIS conference in Rwanda in November 2019.</p>	<p>An overview of the project and the principal CEA results is now in the public domain and can be included in future project proposals for data maintenance.</p>
<p>Continued liaison with the UK Ambassador in Senegal who has taken a keen interest in the work of Airbus and IPP and has offered to brief senior Government staff on future developments.</p>	<p>Contacts have been maintained, including with the new ambassador and other embassy staff, including the new DFID investment advisor.</p>	<p>The project and future developments have been supported by the embassy on several occasions.</p>
<p>Continued liaison by Airbus with DGID on their main priority of the National Cadastre to understand the issues from their viewpoint.</p>	<p>This has also been the main Airbus focus and is now also linked to the concept of a Spatial Data Infrastructure within the requirements of Digital Senegal, and involving all the key stakeholders.</p>	<p>This is an ongoing opportunity but it is also fully dependent upon securing finance.</p>
<p>Continued contact with NAC, our local partner, to identify opportunities for both publicising the change detection techniques and realising benefits of using satellite data.</p>	<p>This has resulted in solid opportunities for supporting the utilities with urban change mapping which are currently being discussed with prospective clients.</p>	<p>Solid opportunities for urban change mapping.</p>

10.2 Assessment of likelihood of future procurement in Senegal and other countries

Based on the situation at Endline and the further activities and developments up until the Legacy Evaluation, Airbus remains positive about the future opportunities for an urban change monitoring service based on the frequent acquisition of Very High Resolution Satellite data such as Pleiades (50cm data) and Pleiades Neo (30cm data, available later in 2020). It is anticipated that the higher resolution data from Pleiades Neo will further improve both the timeliness and availability of satellite data. It will also significantly improve the economics of detailed change monitoring compared with either aerial photography or, except

in relatively small study areas, UAV or drone acquired data, as documented in the project Cost-Effectiveness Analysis.

However, whilst the key stakeholders in Senegal are aligned in their recognition of the value of property data maintenance, the most significant hurdle to implementation is finance. Both the National Cadastre and the property taxation system for Dakar (and other major towns in Senegal) require significant investment before they can be fully operational. Whilst the completion of both will enable significant economic development, revenue generation and realisation of SDGs (especially Goal 17.1), in line with national planning goals, it is the availability of financing to kick-start these activities that remains a barrier. The 2020 coronavirus lock-down and its economic consequences will, unfortunately, impact on all timetables.

Similarly the discussions and demonstrations of change monitoring in other countries are currently on hold, with very little likelihood of advancement during 2020 and it is therefore unlikely that anything much will now happen until 2021. Discussions will continue, where feasible, as will the identification of new country opportunities through the Airbus re-seller network.

10.3 Sustainable Development Goals

Reference has been made in the Purpose and Scope of the project to SDGs and these are summarised in Section 7.7 of this current report. Four goals were stated as relevant and all could be supported through the implementation of a change detection system. This would in turn lead to increased revenues to be spent as suggested in the Dakar Resilience Strategy report, but with the important proviso that although property taxes can be levied at the local level, tax collection is the responsibility of the Ministry of Finance through DGID, and, local authorities remain dependent upon the transfer of the increased funds from the State.

Through the Legacy period this situation has changed little. Property-based tax revenues can assist substantially in the realisation of SDGs. Although this is recognised by the stakeholders and things are moving in the right direction, this is still something to be fully realised in the future.

10.4 Learnings

It remains clear from internet research and from contacts made during and after the project, with organisations such as APTI and RICS, that property tax can be of great benefit to Africa. It is also clear from the technical solution developed during the project in Dakar, and confirmed in discussions with stakeholders, that keeping the database of land and property up-to-date and maintained (by change detection) as an accurate record is a key requirement.

In the Endline Evaluation three lessons learnt were identified as barriers to early introduction of property tax systems in general and the change detection methodology in particular, both in Dakar and elsewhere. These factors are still critical to success and are reiterated here with additional comment.

Firstly that the overall objectives of government should be borne in mind, that is, the introduction of technology, in this case change detection is only the means to an end. The raising of revenues from a property tax is the objective. Technology can only assist.

This is fully realised by the key stakeholders as is the need for data maintenance and the ongoing operational costs that this involves.

Secondly the importance of political will should not be under-estimated which is why Airbus has spent considerable time with DGID and also engaged with the UK Ambassador to gain support and understanding of the project.

The government focus on Digital Senegal and Plan Sénégal Emergent is an important driver in this exercise and a focus for a National Spatial Data Infrastructure by 2025.

Thirdly, an appreciation of the many other factors influencing “the objective” and the understanding and knowledge that can be gained from an awareness of other “players” in the field” For example it is important to be aware of other ongoing major areas of research and practical trials in African countries amongst academia and funding organisations, such as DFID, The Bill and Belinda Gates Foundation and the Rockefeller Foundation at an early stage of any such IPP project.

The Legacy Evaluation has considered various long-term initiatives, such as the Global Platform for Sustainable Cities (GPSC), and the concept of urban data maintenance remains an important component of all of them.

The IPP project was an exciting and rewarding project which illuminated the potential for significant new opportunities for the use of satellite imagery in many different applications and locations in Africa and the developing world. The Legacy Evaluation has confirmed the relevance of the urban data maintenance concept and although it has not yet been developed as an ongoing operational activity the opportunities still exist. Airbus will continue to make the necessary contacts and broaden the knowledge of the contribution that technology can make to the over-riding interests of government and policy makers into how to ensure the maximum impact and outcomes for citizens in line with the Sustainable Development Goals of the United Nations.