ASSESSMENT OF SATELLITE MONITORING SYSTEMS AND GLOBAL MONITORING PLATFORMS IN COTE D'IVOIRE & GHANA

COTE D'IVOIRE SUMMARY

National Wildlife Federation

International Institute for Applied Systems Analysis

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Disclaimer

The objective of this assessment is to inform the selection of a CFI monitoring system. It contains confidential information and shouldn't be distributed broadly. In particular, it shouldn't be used to inform other projects, as information provided by service providers is context-specific and can greatly vary, in particular regarding costs or intellectual property matters.

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Foreword

This assessment was undertaken by The National Wildlife Federation (NWF) and the International Institute for Applied Systems Analysis (IIASA) for the Cocoa & Forests Initiative (CFI). This assessment is done based on information that were provided to the consultants through a series of interviews conducted remotely, via emails and public information available on the internet, and may not reflect the whole capacity/expertise of the service providers assessed. While the utmost care was taken to avoid any misrepresentations, oversights or shortcomings, errors are still possible owing to the nature of the assessment.

The National Wildlife Federation (NWF) is the largest conservation and education organisation in the United States, with over 6 million members and supporters and 51 state and territorial affiliates. NWF draws upon more than 80 years of experience in convening coalitions of diverse partners, including research institutions, regional and national governments and the private sector, to implement long-term solutions to ensure wildlife can thrive in a rapidly changing world. NWF has supported the development and implementation of deforestation monitoring systems for commodity production (both using satellite-based and on-the-ground assessments) for decades, since the inception of the Forest Stewardship Council.

Founded in 1972, the International Institute for Applied Systems Analysis (IIASA) conducts policy-oriented research into problems of a global nature that are too large or too complex to be solved by a single country or academic discipline. The results of IIASA research and the expertise of its researchers are made available to policymakers in countries around the world to help them produce effective, science-based policies. IIASA is sponsored by its National Member Organizations in Africa, the Americas, Asia, and Europe. Its research is independent and completely unconstrained by political or national self-interest.

NWF, IIASA

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Study objectives

*The objective of this study was to carry out an **inventory** and **assessment** of existing **satellite monitoring systems** providing **land cover maps** and **deforestation alerts** in Ghana and Cote d'Ivoire, and existing interactive and functional **web-based platforms** that could host the maps and alerts from the two countries.*

The Governments of Ghana and Côte d'Ivoire and the world's leading cocoa and chocolate companies signed landmark agreements in November 2017 to end deforestation and promote forest restoration and protection in the cocoa supply chain. This new public-private partnership – called the Cocoa & Forests Initiative (CFI) – has been facilitated by the World Cocoa Foundation (WCF), IDH - the Sustainable Trade Initiative, and The Prince of Wales's International Sustainability Unit (ISU), under the leadership of the Governments of Ghana and Côte d'Ivoire. The Frameworks for Action for Ghana and Côte d'Ivoire were signed in November 2017 and define core commitments, verifiable actions, and timebound targets required for a deforestation-free cocoa supply chain.

The Framework for Action states the following on the monitoring of cocoa-related deforestation:

"Adoption of a transparent satellite-based monitoring system, the results of which are independently validated, and which provide a deforestation alert, complemented with ground-truthing, as soon as possible upon signature of this Framework, which will be made publicly available for all stakeholders to measure and monitor progress on the overall deforestation target".

Measurement and monitoring of progress at national and landscape level will be critical to ensure accountability, transparency and promote learning and mid-course corrections. The government will adopt a transparent satellite-based monitoring system, including deforestation alerts, with the aim to have a system adopted by the end of 2019. National monitoring will be directly aligned with REDD+ monitoring, reporting and verification systems. Companies will produce annual reports on CFI progress and are already working with several service providers to monitor deforestation in their individual supply chain.

This study aims to provide a neutral assessment of existing satellite monitoring systems, to support the Government decision-making. It was performed jointly by the National Wildlife Federation and the International Institute for Applied Systems Analysis, in the period June – July 2019.

This document focuses on the service providers that operate in Cote d'Ivoire.

The scoring of the Ghana-specific service providers was removed from the core of the document, to avoid any mis-interpretation. It can however be found in the annex of this document.

Definitions

This assessment is looking at three related aspects of measurement and monitoring; namely Land Cover Maps, Deforestation Alerts and Monitoring Platforms. A monitoring system begins with the establishment of land cover base maps, which provide a snapshot of the landscape at a given point in time. These maps would ideally be produced annually. Deforestation alerts are produced more frequently and focus entirely on changes to the existing land cover related to cocoa. Monitoring Platforms are then designed to store, manage and host the aforementioned data, making it easily accessible for non-technical experts. Some service providers offer the entire suite of products, including land cover maps, deforestation alerts and a monitoring platform, while others focus exclusively on the platform and use available data (either openly available for private data).

Reference map: Remotely sensed representation of a landscape with defined elements (e.g. forest, cocoa plantations, others) for a given time. This is the baseline map which provides a snapshot of the landscape at a given point in time.

Deforestation Alerts: Timely warnings (e.g. quarterly) of changes in the forest canopy attributed to cocoa. These then ultimately feed into revised versions of the land cover maps.

Monitoring Platforms: Online platforms providing users with secure access to analyze the above-mentioned data over time. National platforms could host national data, with a common platform hosting various national datasets for the CFI.

Methods

In order to perform this assessment, we applied the following methodology:

1. Determined potential actors
2. Structured templates
3. Completed telephone/online surveys and demos
4. Produced detailed factsheets
5. Extracted scores
6. Summarized findings

In total, more than 70 criteria were determined against which to evaluate the existing systems. The majority of the questions were technical in nature, and covered details such as resolution, accuracy, ground-truthing and data types. See the fact sheets for more details.

In total, 11 vendors were considered at the outset across both Ghana and Cote d'Ivoire. Of these, only eight were scrutinized in detail with detailed factsheets produced. ETH Barry Callebaut, FAO/OpenForis and SST Systeme National were not included in the assessment owing to the maturity of their cocoa specific capabilities. Four providers, namely Ecometrica, IMAGES/Vivid Economics, Satelligence and Starling offer the complete monitoring system and platform. Other vendors offer web-based platforms using global open data – see Table 1 and the specific factsheets for details. The following is a short description of each vendor and their range of services:

Table 1: Overview of the elements of a monitoring system offered by service providers.

	National reference maps produced	**Real-time deforestation monitoring**	**Dedicated platform offered**	**Fact sheet prepared**	**Operating in...**
Ecometrica	**x**	**x**	**x**	**x**	Ghana
GFW Pro			**x**	**x**	Ghana & **Cote d'Ivoire**
IMAGES	**x**	**x**	**x**	**x**	**Cote d'Ivoire**
MapHubs			**x**	**x**	**Cote d'Ivoire** (campaign)
Open Forests			**x**	**x**	
Satelligence	**x**	**x**	**x**	**x**	Ghana**; Cote d'Ivoire (pilot)**
Starling	**x**	**x**	**x**	**x**	Ghana & **Cote d'Ivoire**
WRI Forest Atlas			**x**	**x**	Congo Basin, Liberia, Madagascar

Ecometrica, founded in 2008 is a global company partnered with ESA and the UK Space Agency. The current emphasis is on the creation of base maps for Ghana, segregation of tree crops in particular cocoa from natural forest. Detecting and mapping forest degradation with deforestation alerts is currently under development and testing. Ecometrica through the Resource Management Support Centre (RMSC) and KNUST have been conducting field work to delineate cocoa and other three crops from forests, differentiating full-sun cocoa from cocoa agro-forestry systems. Maps are generated at two levels: RMSC generates the maps and KNUST provide quality control. The maps are further subjected to expert review and comments from the expert are used to refine and finalized the maps. This is currently being scaled up to cover the entire Emission Reduction Program Area ERPD of REDD+ i.e. the cocoa sector in the country. The segregation is being assisted by structure for motion using drone technology with less than 2 cm accuracy. Under the project all admitted farms have been digitized and currently being validated by the Resource Management Support Centre. They have recently signed a contract to continue working closely with the Forestry Commission in Ghana for the next years. Funding is provided by Ecometrica and the private sector, however a percentage of the money is sent to RMSC to continuously generate data and maps.

The Forest Atlas is a platform-only tool to visualize and store data for download to the public. It is offered by WRI in in conjunction with GFW Pro and has the capacity to immediately integrate data from Global Forest Watch, such as Landsat mapping and GLAD alerts. But further integration of datasets like protected area boundaries/land cover maps which differentiate cocoa from natural forests would need to be provided by respective government departments. Therefore, much of the monitoring system criteria is not applicable to Forest Atlas.

GFW Pro is an online platform. Per default, it hosts global-scale University of Maryland (UMD) data for both the reference and deforestation maps and the technical description refers to these. For the CFI, in order for more in depth monitoring of the cocoa sector, integration of national data sets like protected area boundaries/land cover maps which differentiate cocoa from natural forests would need to be provided by respective government departments and other private service providers, many of which are equipped and willing to integrate their datasets with GFW Pro.

IMAGES was created in 2016 for the Ivorian government and other key stakeholders to address some of the country's needs in tackling deforestation. The development of the tool was co-funded by Vivid Economics, RSAC, and the UK Space Agency. IMAGES is now in use in South West of Cote d'Ivoire and is being maintained by the Ministry of Planning and Development. IMAGES forest loss maps are updated every 12 days, highlighting recent forest loss alongside strategic land use planning data. Work has been done in Cote d'Ivoire to assess accuracy of the system and cocoa detection, which can be confidently distinguished from forest. IMAGES is currently being scaled up to cover the entirety of Cote d'Ivoire by mid-2020 and is currently working confidentially with some CFI signatories.

MapHubs does not produce its own Land Cover maps or alerts, but can use any open, public or commercial Land Cover and deforestation alert data. By default, MapHubs comes with the same data as GFW Pro: Hansen Tree Cover Loss and GLAD alerts. MapHubs has also done work using data from Vivid Economics. Also, MapHubs has recently launched the reporting protocol "Forest Report", which provides monthly reports assessing high risk areas for key commodities, along with corresponding maps illustrating recent satellite imagery. This is done using University of Marylands 30m resolution data from Landsat, but it is also compatible with Sentinel data (10m resolution). MapHubs and Forest can use any open, public, or commercial LC and deforestation alert data. The system can be configured to use the best available data.

Open Forests supports organizations to acquire satellite, drone, and field data to assist with remote sensing and data analysis tasks. Because this work is currently conducted on a project by project basis, reference maps and ground truthing have not yet been completed in Cote d'Ivoire and Ghana, but Open

Forests is looking to expand their technology there. The current system allows for weekly deforestation alerts. Detection of cocoa has not been tested, but similar work is currently being done with eucalyptus in Kenya. Work has not been done directly with CFI signatories, but Open Forests welcomes any collaboration.

Satelligence is a monitoring system that provides granular monitoring data updated daily, globally, with weekly reports. Satelligence has been conducting on the ground assessments for mapping in Ghana, coordinated by local staff in Accra. The monitoring can confidently distinguish forest from both agro-forestry and full sun cocoa. Satelligence's work has focused on private companies, including work with some CFI signatories, but has not directly worked with Ghanaian or Ivoirian governments. Part of Satelligence's development process is grant-based, but it is mostly funded by client payments.

Starling's monitoring system was created by the joint investment of Airbus and Earthworm. Much of the mapping is provided by Airbus' constellation of satellites and the processing of these maps is done through Airbus. Currently Starling is working on mapping the majority of both Cote d'Ivoire and Ghana, with local staff based in Abidjan and Accra. From a pilot project in Cavally Forest, Starling was able to distinguish full sun cocoa from forest. Using high-resolution radar (TerraSarX), Starling is able to detect forest degradation to identify high risk areas for under canopy cocoa. Starling primarily supports businesses on their zero deforestation commitments, but also supports the public sector, for examples it is working with SODEFOR on the Cavally classified forest.

Results

The areas or coverage where the providers are actively working is provided below initially. The following assessment was made based on extracting scores from the completed surveys. We assigned a 1 for a response that fell completely within the requirements, 0.5 for meeting the requirements partially and zero for not meeting requirements or not providing an answer. From these scores we created an overall compliance percent in the following tables. See Appendix for detailed scores and the fact sheets for the original data.

Cost estimates were determined through consultations with the service providers. At this point they are very approximate and would have to be refined based on a specific Terms of Reference. Furthermore, some of these costs are already partially covered by existing funding and this will have to be further discussed with the service providers.

Coverage

Provider	Criterion	Value/Information	Detail
Ecometrica	Regions covered currently	SW Ghana	Currently being scaled up
Forest Atlas	Regions covered currently	9 countries	Cameroon, DRC, Republic of Congo, Central African Republic, Equatorial Guinea, Gabon, Liberia, Madagascar, Georgia
GFWPro	Regions covered currently	Global	
IMAGES	Regions covered currently	Southwest Cote d'Ivoire	All of Cote d'Ivoire as of Q2 2020
MapHubs	Regions covered currently	Global	
OpenForests	Regions covered currently	South East Asia and Latin America, Kenya	
Satelligence	Regions covered currently	Western Ghana & West Cote d'Ivoire	Tentative plans to map all of Ghana
Starling	Regions covered currently	Currently working to cover all of Cote d'Ivoire and Ghana below the 8th parallel.	Plan to have full coverage of CdI and Ghana in Q2/3 2019.

Reference map

Provider	*Score* *(see Appendix and Factsheets for details)*	*Costs* ***(Approximate, will have to be confirmed based on ToR)***	*Comments*
IMAGES	82%	€190 K/yr (current map access) €255 K/update (reference map update fee)	Low total costs, planned updates only every 2-3 yrs. Currently covers SW Cote d'Ivoire, full country planned Q2 2020.
Satelligence	100%	€150 K/yr for initial map	Costs reasonable, Robust methods and accuracy, peer-reviewed
Starling	86%	Total package estimate of €400 -500 K/yr	Accuracy assessment ongoing. Initial quality checks have been performed and results are promising, but a more rigorous validation would be required.

IIASA/NWF Recommendations:

Cote d'Ivoire – Starling likely best-placed to deliver owing to their high score and in-country expertise. Costs are however in the mid-high range. According to the assessment, full coverage of Ghana and CdI should be available.

Deforestation alerts

Provider	***Score*** *(see Appendix and Factsheets for details)*	*Costs* *(Approximate, will have to be confirmed based on ToR)*	***Comments***
IMAGES	79%	€50 K/yr (near real-time alerts) €100 K/update (alert system update)	Accuracy assessment not completed. Some field visits and visual inspections were done, but more is needed to be certain of quality.
Satelligence	100%	€400 K/yr	Robust methods and accuracy, high costs
Starling	86%	Total package estimate of €400 -500 K/yr	Accuracy assessment ongoing, temporal resolution not sufficient

IIASA/NWF Recommendations:

Cote d'Ivoire – Both Starling and IMAGES best placed in terms of in-country expertise, however Starling not currently meeting the temporal requirements (forest change alerts are currently produced at 6-month intervals which is too long – however an 11-day turnaround is possible). Both need to complete accuracy assessments. Initial accuracy assessments have been performed, however both providers would need to complete robust, independent validation of their alerts and report their accuracy levels. This would require field visits.

Monitoring platforms

Provider	*Score*	*Costs* *(Approximate, will have to be confirmed based on ToR)*	*Comments*
Ecometrica	78%	Unknown	Work with Forestry Commission, offer total system (Reference Maps, Deforestation Alerts, Monitoring Platform)
Forest Atlas	89%	€450 K/yr	Global experience, high costs, platform only
GFWPro	94%	€1 Million lump sum	Global experience, high costs, platform only
IMAGES	83%	No extra charge	Low cost, offer total system (Reference Maps, Deforestation Alerts, Monitoring Platform)
MapHubs	94%	€50 – 75 K/yr	Low cost, platform only
OpenForests	78%	Unknown	Visually appealing platform, no costs provided, no in-country experience
Satelligence	83%	€50 K/yr	Low cost for platform, offer total system (Reference Maps, Deforestation Alerts, Monitoring Platform)
Starling	86%	Total package estimate of €400 -500 K/yr	Platform costs included in total package, offer total system (Reference Maps, Deforestation Alerts, Monitoring Platform)

IIASA/NWF Recommendations:

Cote d'Ivoire – both IMAGES and Starling would be well placed to offer complete systems including the monitoring platform.

CFI – to facilitate monitoring of CFI across countries, the recommendation would be that one web-based platform is used for both Ghana and Cote d'Ivoire. From the platform only providers, GFWPro and Forest Atlas obviously have the most experience along with very robust systems. Their costs however are prohibitive, and more precise cost estimates would need to be collected from the organization that leads their development, the World Resources Institute. The smaller systems (i.e. MapHubs and OpenForests offer attractive systems at potentially much reduced costs, albeit with little in-country or cocoa experience. This may however not be an issue when providing a monitoring platform.

Gaps and recommendations

The following are some general gaps and recommendations coming out of the assessment:

Costs – not all providers have given cost estimates, and those that have are clearly stating that these are estimates only. Accurate costing can only be done with a ToR via a tender. **Thus, ToR's must be produced and put into a tender for the cocoa monitoring system.**

Accuracy – each of the providers is at various stages in terms of accuracy assessment and validation. As per the CFI, all data needs to be independently validated. **A system would need to be put in place and agreed upon to ensure robust validation by an independent party.**

Operational – ensure that all systems offered by the providers are in fact operational. All other providers claim that their products are available, however that would need to be confirmed. **The provision of test data at pilot sites could be one solution to examine this.**

Transparency – the transparency of the providers is of the utmost importance. In this assessment we have assumed that all providers are providing the most accurate information available to them at the time of the assessment. Nonetheless, there appears to be varying levels of transparency among the providers, with some very forthcoming in their answers and others less so. **The findings provided here can be used to guide decision making but should not be assumed to be entirely accurate. More detailed fact-checking would need to be undertaken – see above mention of pilot sites.**

Public Availability – In general the providers were vague on the issue of public availability of the data. However, most providers said that it would be possible with the proper terms and conditions. **Hence, the CFI will need to draft guidelines for data provision such that the resulting reference maps and deforestation alerts are publicly available.**

Next steps

The IIASA-NWF consortium can help the Cote d'Ivoire Government write the Terms of Reference on what would be needed for the selected service provider(s) to fill the gaps that have been identified in this current assessment. The selected service provider(s) will respond to this ToR and give a more refined estimate on what would be needed to fill the gaps.

APPENDIX – Detailed scoring (service providers operating in both Cote d'Ivoire and Ghana)

In compliance with the CFI Framework for Action Commitment, requirements were specified for each of the criterion that needed to be met or exceeded to receive a full score, or partially addressed to receive a half score. If no answer was provided or the requirement was not met, a zero score was assigned. The requirements specified that the reference map must have: Data Source(s) – Sentinel and others; Map Year - >= 2018; Spatial Resolution - < 100 m pixels; a Minimum Mapping Unit of 0.5 ha or less; Temporal Resolution with a frequency of at least 1 year; Include at least 5 land cover classes (including cocoa); Consider Admin Boundaries; Accuracy of forest classes > 80%; Distinguish cocao vs forests (> 75%); accuracy of cocoa detection (>75%); distinguish full-sun vs agro-forestry cocoa and detect cocoa under canopy.

Reference map					
Criterion	**Requirement**	**Ecometrica**	**Starling**	**Satelligence**	**IMAGES**
Data Source(s)	Sentinel, others	1	1	1	1
Map Year	>= 2018	1	1	1	0.5 2019 as of Q2 2020
Spatial Resolution	< 100 m	1	1	1	1
Minimum Mapping Unit	< 0.5 ha	1	1	1	1
Temporal Resolution	<= 12 months	1	1	1	0.5 Every 2-3 yrs
Land cover (LC) classes represented	> 5 incl. cocoa	1	1	1	1
Considers Administrative Boundaries	yes	1	1	1	1
Accuracy of forest classes	> 80%	1	1	1	1

Distinguish cocoa vs. forests	> 75%	1	1	1	1
Accuracy of cocoa detection	> 75%	1	0.5 Assessment ongoing	1	1
Distinguish full sun vs. agro-forests cocoa	yes	1	0 Definition unclear	1	0 Indicated no
		100%	**86%**	**100%**	**82%**

1 = full compliance; 0.5 = partial compliance; 0 = no compliance

In compliance with the CFI Framework for Action Commitment, requirements were specified for each of the criterion that needed to be met or exceeded to receive a full score, or partially addressed to receive a half score. If no answer was provided or the requirement was not met, a zero score was assigned. The requirements specified that the reference map must have: Operational alerts; data sources (i.e. Sentinel and others); Spatial resolution < 100 m; minimum mapping unit < 0.5 ha; temporal resolution < 3 months; an accuracy > 80% and the ability to monitor forest regrowth.

Deforestation alerts					
Criterion	**Requirement**	**Ecometrica**	**Starling**	**Satelligence**	**IMAGES**
Alerts operational as of Q4 2019	Yes	0.5 Unclear if operational	1	1	1
Data Source(s)	Sentinel, others	1	1	1	1
Spatial Resolution	< 100 m	1	1	1	1
Minimum Mapping Unit	< 0.5 ha	1	1	1	1
Temporal Resolution	< 3 months	1	0.5 Approx. 6 months	1	1
Accuracy	> 80 %	1	0.5 Assessment ongoing	1	0.5 Not assessed systematically
Ability to monitor forest regrowth	yes	1	1	1	0 Not considered
		93%	**86%**	**100%**	**79%**

1 = full compliance; 0.5 = partial compliance; 0 = no compliance

In compliance with the CFI Framework for Action Commitment, requirements were specified for each of the criterion that needed to be met or exceeded to receive a full score, or partially addressed to receive a half score. If no answer was provided or the requirement was not met, a zero score was assigned. Owing to the size of the following table, please refer to the detailed fact sheets for an explanation of scores.

Monitoring system									
Criterion	Requirement	Ecometrica	Starling	Satelligence	GFWPro	IMAGES	Forest Atlas	MapHubs	OpenForests
Secured access to platform possible	yes	1	1	1	1	1	1	1	1
Common space for all signatories	yes	1	0.5	1	1	0	0	0.5	0
Private space/Possible to add confidential layers	yes	1	1	1	1	1	1	1	1
Multi-hierarchy access possible	yes	1	0.5	0.5	1	0	0.5	1	1
Possibility to migrate system to signatory-specific server	yes	0	0.5	1	0.5	1	1	1	0
Functionality with GIS	yes	0	1	1	1	1	1	1	1
Compatible with GPS	yes	0.5	1	1	0.5	1	1	1	1
Mobile Version Available	yes	1	1	0.5	1	1	1	0.5	1
Possible to Integrate Data from foreign sources	yes	1	1	1	1	1	1	1	1
Restrictions to # users at a time	no	1	1	1	1	1	1	1	0
Traffic limitations	no	1	1	1	1	1	1	1	0
Ease of navigation	Good	0.5	0.5	1	1	1	1	1	1
Data Visualization Possible	Yes	1	1	1	1	1	1	1	1
Easily change between years	yes	1	1	1	1	1	1	1	1

Drawing tool to select an area?	yes	1	1	0	1	1	1	1	1
Possible to select & analyze more than one zone at a time?	yes	1	1	0	1	0	0.5	1	1
Export of data and analysis possible? In what format?	yes	0.5	1	1	1	1	1	1	1
User guide and tutorial available	yes	0.5	0.5	1	1	1	1	1	1
		78%	**86%**	**83%**	**94%**	**83%**	**89%**	**94%**	**78%**

1 = full compliance; 0.5 = partial compliance; 0 = no compliance