IMPACT EVALUATION EARLY EVIDENCE SERIES | MAY 2019

BRIEF

CIF CLIMATE INVESTMENT FUNDS

Innovative Dry Forest Mapping

OBJECTIVE

An ongoing impact evaluation of the African Development Bank's (AfDB) Gazetted Forests Participatory Management Project for REDD+ in Burkina Faso is assessing several pressing issues, including the devising of innovative dry forest mapping methods that allow the estimation and measurement of forest cover using ground truth points. The project is supported by the Climate Investment Funds' (CIF) Forest Investment Program (FIP), and the evaluation is conducted in partnership with the World Bank Group's Development Impact Evaluation (DIME). The objectives of the project are two-fold: improving the carbon sequestration capacity of gazetted forests while reducing poverty in rural areas. Understanding the real impacts of forest conservation policies, however, requires accurate measurement of forest cover and related trends. It calls for generating dryland-specific forest cover datasets so that the effectiveness of forest policy interventions can be measured and evaluated, and lessons can be drawn. Monitoring REDD+ progress requires governments to develop greater capacity to measure and monitor forest cover, including tracking changes resulting from conservation and reforestation programs.

COUNTRY Burkina Faso

PROJECT Gazetted Forests Participatory Management Project for REDD+

CIF FUNDING USD 11.5 million from FIP

MDB African Development Bank

PRODUCT TYPE Development Impact Evaluation (DIME)

WHY FORESTS MATTER

Forests are an essential component of the global ecosystem.

They provide habitats for animals, help conserve water and soil, capture and store carbon, and provide livelihoods to populations that depend on them. Forest cover loss accounts for between 12 and 15 percent of annual human-driven greenhouse gas (GHG)[1] emissions. Forest protection, reforestation and afforestation strategies therefore present an important and cost-effective means to mitigate climate change.

THE IMPORTANCE OF FOREST COVER MAPPING

Effective protection of forest resources requires detailed knowledge about the state of forests, as well as the capacity to monitor changes. More importantly, conservation policies such as payments for avoided deforestation, and stock-takings such as forest conservation, impact assessments, require regular and accurate forest size estimations, along with indications of any related changes. To this end, the project has built on global approaches to forest mapping, and has tailored them to a localized context, thus creating tree cover maps for select gazetted forests in Burkina Faso.

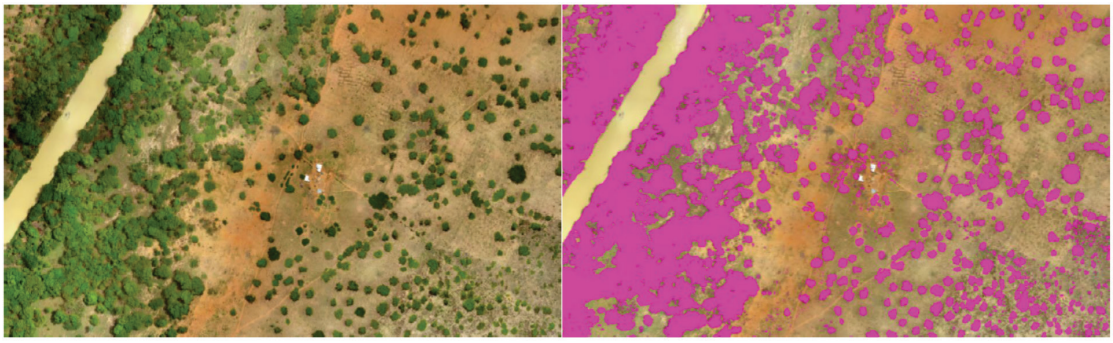
REMOTE SENSING TECHNOLOGIES AND TREE COVER MAPPING IN DRY FORESTS

The project has utilized images from the European Space Agency's (ESA) fleet of Sentinel satellites, which provide high-resolution imagery for Earth-observation purposes. These satellites help monitor land surface conditions over large areas

1. Canadell, J.G., Gullison, R.E., Frumho_, P.C., Field, C.B., Nepstad, D.C.,Hayhoe, K., Avissar, R., Curran, L.M., Friedlingstein, P., Jones, C.D., Nobre, C., 2007. *Tropical forests and climate policy.* Science 316, 985-986.

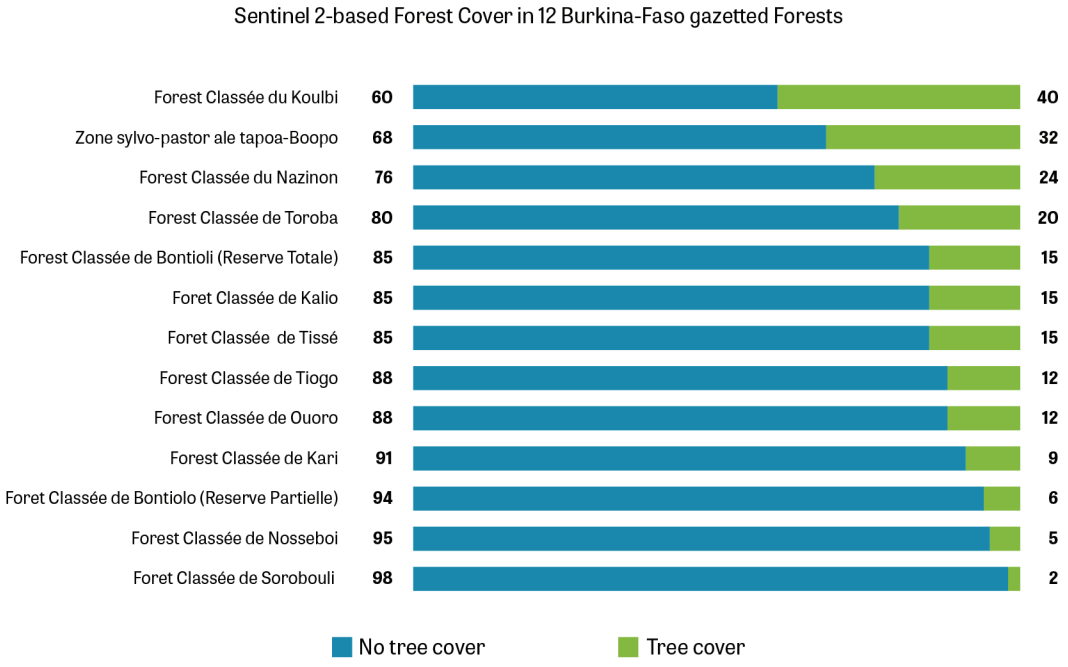
FIGURE 1: PRECISE TREE COVER MAPPING ON DRONE IMAGES

Artificial Intelligence at work. DIME's ongoing work shows that high precision mapping of tress in dry forests is possible!



Understanding the real impacts of forest conservation policies requires accurate measurement of forest covers stocks and trends. On the left is a drone image taken inside Bontioblo forest in Burkina Faso (centroid located at -3.077711, 10.805546). The 0.1m resolution image shows sparsely distributed trees, built-up areas, water bodies, and crop fields. A supervised classification using Random Forest was able to predict tree cover with an accuracy rate close to 100%. Tree cover classified pixels are shown in pink over the drone image on the right.

FIGURE 2: SATELLITE MAPPING OF FOREST COVER



Source: Adjognon et al. (2018)[2]

2. Adjognon, G. S., Rivera-Ballesteros, A., & van Soest, D. (2018). Satellite-based tree cover mapping for forest conservation in the drylands of Sub Saharan Africa (SSA): Application to Burkina Faso gazetted forests. *Development Engineering,* 100039.

every 10 days, and support the ESA Copernicus environmental studies program, which includes the monitoring of vegetation, soil, water and coastal areas. These images, and related processing technology, are available at little to no cost. This means that Burkina Faso can routinely and precisely map forest cover using extremely cost effective and easy-to-use methods.

Preliminary results of Sentinel-based mapping showed that tree coverage was low in the 12 forests targeted by FIP in Burkina Faso (see figure 1), consistent with expectations for the country's dry agro-climatic conditions. In order to thereafter validate the accuracy and classification of satellite images, the team deployed a pilot initiative that utilized drone imaging to gather high-resolution ground truth data from a sample of representative areas. Imaging was done in 5 forests across Burkina Faso, capturing a variety of agro-ecological conditions and spectral tree signatures. The intention of the exercise was to train satellite-to-drone imagery matching, whereby the low-cost, high-frequency imagery obtained by the Sentinel satellites could be interpreted to provide detailed forest cover estimates for all 12 project areas—in effect, setting up a regular forest monitoring system for the government. The inclusion of drone imagery has shown significant improvements in image precision for establishing ground truth data..

MONITORING SURVIVAL RATES IN AFFORESTATION PROGRAMS

On-the-ground mapping of specific locations in an

afforestation program can also be done at low cost. Approximately 33,000 trees were planted in this project. With minimal training, project teams on the ground have been able to use the ESRI Survey123 tool to geo-reference the trees planted in different parts of the forests. To further streamline the monitoring of these trees, a virtual forest corridor was created that allowed teams to verify the survival rates within a narrow band.

In Burkina Faso, and in many other countries implementing largescale afforestation programs in the drylands, there has often not been a system in place to accurately record, geolocate, and track the survival rates of the trees planted, limiting the ability to learn about the conditions that are conducive to their sustainability. This project has been able to demonstrate that high-precision mapping of forest cover in dry forests is possible and can be done at a low cost and with easy-to-use techniques. Geospatial technologies were used to track the precise survival rates of reforested trees to between 30 and 37 percent using a variety of different species of trees. By establishing what could be baseline survival rates, this innovative low-cost scheme presents important landscape restoration opportunities that could guide and prioritize both national and international forest conservation policies. Establishing accurate baseline reforestation survival rates provides the ability to measure and quantify forest conservation methods in a way that was not previously possible.

EMERGING EARLY LESSONS

This work demonstrated the viability of utilizing low-cost, higher-resolution Sentinel-2 satellite images to map forest cover in dryland forests: a method now fully incorporated into the routine measured, reported and verified (MRV) REDD+ forest monitoring in Burkina Faso. If successful, the approach could be scaled up to several other countries in the Sahel region.

This innovative approach, coupling tree planting with precision survival rate tracking, should be tested in several other contexts to improve the ways in which afforestation activities are implemented and results are enhanced. This is becoming increasingly important as most dryland countries' NDCs involve ambitious forest landscape restoration plans. As this initiative forms part of a REDD+ readiness project, the tools and lessons developed are also intended to inform the efficient planning of the REDD+ implementation phase.

The World Bank's Development Impact Evaluation (DIME) group generates high-quality and operationally-relevant data and research to transform development policy, help reduce extreme poverty, and secure shared prosperity. It develops customized data and evidence ecosystems to produce actionable information and recommend specific policy pathways to maximize impact.

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TRANSFORM DEVELOPMENT

For more information, please visit
http://www.worldbank.org/en/research/dime
www.climateinvestmentfunds.org

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