# Terms of Reference

**Methodology for estimating deforestation and forest degradation in Fiji using Landsat time-series data**

## 1. Background

The Forest Carbon Partnership Facility (FCPF) is supporting Fiji to enable the country to participate in REDD+ processes and to harness benefits of the result-based payments for REDD+. As part of the readiness, Fiji has developed Forest Reference Level (FRL) for the ER program covering the three islands of Viti Levu, Vanua Levu, and Tavauni; and initiated the design of National Forest Monitoring System.

Fiji has developed FRL covering deforestation, forest degradation, and enhancement of carbon stock as major REDD+ activities. For the FRL, deforestation is defined as the conversion from Natural Forest to Non-Forest.

The term "forest degradation" has not yet been (formally) defined in Fiji. No direct method is devised to measure forest degradation. For establishing FRL, a proxy method was used to estimate emissions from loss of density of natural forests (. Data on harvested timber volumes in natural forest was used as a proxy for forest degradation.

Fiji has used Landsat remote sensing data to assess emissions from deforestation. However, monitoring and estimating forest degradation using Landsat remote sensing data remains a challenge. While there are established methods for tracking forest disturbance using image processing techniques such as spectral mixture analysis, there is no single method that can be applied to monitor forest degradation largely because of the specific nature of the degradation types, processes, and the time frames over it is observed.

This work proposes to build upon the efforts of Fiji in utilizing multitemporal Landsat in order to assess land cover change to estimate forest degradation.

## 2. Objectives

The objective of this assignment is to apply change detection algorithms to time series of Landsat imagery to detect forest change and sample-based statistical inference to estimate forest degradation.

## 3. Sources of activity data

Fiji has used time-series Landsat data from 2005 to 2017 to construct the forest reference level. There have been challenges associated with obtaining clear Landsat images of Fiji because of significant cloud cover. Since May 2013, complete Landsat 8 archive is available which consists of 23 images per year. Prior to year 2013, only limited images are available.

Fiji utilized available Landsat imagery to prepare annual time-series maps for the reference period 2006-2016.

## 4. Task

The consultant will provide the following services.

- Present a methodology to estimate emissions from forest degradation in Fiji. The methodology will track changes between pre-defined forest classes such as open and closed forests.
- Evaluate the performance of the Continuous Degradation Detection (CODED) in generating activity data on deforestation and degradation of Fiji.
- Compare the CODED approach using the annual Landsat composites created by the REDD+ Unit, and the full Landsat archive available through the Google Earth Engine.
- Compare the results of land cover change estimated by Fiji for 2006-2016 reference period with the results from CODED algorithm and assess the accuracy and computational efficiency of the two approaches.
- Using a samplebased approach, assess the accuracy of forest disturbance maps and assess its efficiency for area estimation of forest degradation.
- Provide a framework for creating a map of deforestation and degradation, using sample-based appraoch, interpretation of the sample, and estimation of the areas of activity data with confidence intervals. The framework will be demonstrated for the reference period.
- Training to the staff of Management Services Division of Fiji Ministry of Forestrry on the data, algorithm, its application and analysis to estimate forest degradation.

## 5. Data

Fiji REDD+ unit is expected to share the annual time series Landsat maps and training data to be used to estimate forest degradation.

## 6. Time required

The estimated number of days including the ground truthing of the results of deforestation and forest degradation is 30 days (the consultant will report actual number of number of days used for data analysis and ground truthing).

## 7. Deliverables and payment schedule

(i) A report on the methodology to estimate forest degradation in Fiji and accuracy assessment of estimates of forest degradation using the methology.

(ii) Estimates of defiorestation and forest degradation of Fiji along wityh uncertainty estimates demonstrating the methodology.

(iii) Data, documentation and training to the Management Services Division to perform the analysis

(iv) Payment to be made upon receiving the final report of the analysis.

## 8. Reporting arrangements

The consultant will report to Fiji REDD+ Unit and addresses to Mr. Ilai Tulele (tulele.ilai@live.com), Dr. Narendra Chand (narendrachand@gmail.com), and Mr. Viliame Tupua (vtupua@gmail.com).

## 9. Consultant qualifications

The consultant will have the following qualifications;

- Advanced Degree in Remote Sensing and Geographical Information System
- Demonstrated knowledge and skills in estimating carbon emission from forest degradation
- Strong skills in using statistical analysis
- International experience working in different geographic regions, knowledge of the Pacific region is an advantage.

## 10.Selection procedure

A consultant will be selected using the World Bank's Selection of Individual Consultant method. For further details, refer to the World Bank's Guidelines: Selection and Employment of Consultants under IBRD Loans and IDA Credits & Grants by World Bank Borrowers, January 2011 (Revised July 2014).

## 11. Contact

For further information on these terms of reference, please contact:
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