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# Final Project Delivery Report

## Forest Information Management System - National Forest Monitoring System Integration Framework for Fiji

50 Charles Crt
Lake Hawea
NEW ZEALAND

E: info@enviroaccounts.com

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Document Status

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**Authors:**
Michael Green (BCSc)
Dr Carly Green (BEnvE, PhD)

# Abbreviations

| | |
|---|---|
| CMS | Content Management System |
| ER | Emission Reduction |
| ERP | Emission Reduction Program |
| FCPF | Forest Carbon Partnership Facility |
| FIMS | Forest Information Management System |
| FRL | Forest Reference Level |
| MRV | Measurement, Reporting and Verification |
| NFMS | National Forest Monitoring System |
| REDD+ | Reducing Emissions from Deforestation, Reducing Emissions from Forest Degradation, Conservation of Forest Carbon Stocks, Sustainable Management of Forests, and Enhancement of Forest Carbon Stocks |

# Contents

# 1 Introduction

In June 2019, Fiji was accepted into the Carbon Fund of The World Bank Forest Carbon Partnership Facility (FCPF). The country is now progressing toward the implementation of its 5-year Emission Reduction National Program (ERP) under the Carbon Fund. Actions completed during this program will lead to the generation of Emissions Reductions which are calculated against Fiji's established Forest Reference Level (FRL).

To receive results-based payments under the Carbon Fund, Fiji requires an operational National Forest Monitoring System (NFMS) capable of fulfilling measurement, reporting and verification (MRV) requirements as set out in the FCPF Guidelines. The requirements include producing consistent estimates of greenhouse gas emissions from REDD+ activities at specified points in time, the comparison of annual emissions and removals against a determined FRL, the ability to appropriately manage document control and transparently communicate the processes of the NFMS.

Fiji's REDD+ Unit within the Ministry of Forestry has established an NFMS which has evolved through a series of independent contracts for the various system elements. The annual activity data from remote sensing, collection of data from Plantations Companies and the estimation methodology for both determining the national FRL and accounting for estimating ERs required integration to ensure transparent and consistent monitoring, reporting and verification to meet National reporting objectives, including to the FCPF Carbon Fund.

## 1.2 Terms of Reference

The project *"Designing a National Forest Monitoring System Integration Framework for Fiji"* started on 3 March 2020. The project aim was to deliver a user-friendly interface (i.e. integration framework) linking the existing National Forest Monitoring System (NFMS) database to the Forest Reference Level (FRL) and Emission Reduction methodology. The project also aimed to institutionalise and operationalise this framework, through training, capacity building and documentation so that the integration framework would become a fundamental MRV process within the Ministry of Forestry to meet its REDD+ reporting requirements. The contract specified that this would be achieved by:

- developing software and tools with a user-friendly interface to integrate and operate the FRL and ER calculation R script against collected data sets.
- update the R scripts and documentation to calculate the emission reductions for each monitoring period;
- develop Standard Operating Procedure/s (step by step instructions) for running NFMS Integration Tool and generating estimates; and
- conduct staff training on the running and management of the NFMS Integration Tool.

The following results were anticipated to be achieved from this contract:

- Fiji MSD staff can independently operate the R Script Calculations for future monitoring periods
- Calculations for FRL and ER estimates are repeatable and consistent
- The format of outputs form the integration framework are consistent with available monitoring report templates of the FCPF.

## 1.3 Purpose of the final report

The purpose of this final report is to document and demonstrate how the Terms of Reference was completed; to outline how some of the realised project risks were overcome; and provide some suggestions for future extensions of the Forest Information Management System.

## 1.4 Structure of the final report

This final report is structured into the following sections:

**Section 1 -** outlines the Introduction to the Report defining the expected outcomes from this contracted work.

**Section 2 -** describes the activities undertaken to complete the scope of work and some of the challenges faced and how these were overcome.

**Section 3 -** defines the final deliverables provided to Fiji's Ministry of Forestry.

**Section Suggested Next Steps4 -** outlines some suggestions for possible next steps.

The Appendices present more detail of information relevant to the final report collected and generated during the Project.

## 1.5 COVID-19 impacts on delivery

The delivery of this contract was impacted by COVID-19. International travel restrictions and local lock downs in both Fiji and New Zealand severely limited the ability to complete this project on the original timeline. This was identified in the inception report and addressed in the subsequent resubmission of a revised work plan.

The COVID restrictions limited the ability to connect seamlessly to the existing database in Fiji; had implications on the training for capacity building; and caused changes to the deployment process which had to be facilitated remotely. All of these adaptations to the initial work plan have resulted in time delays to implement the system in Fiji.

However, the delays in delivery of this project also offered an opportunity to test the full system to develop the estimates for the 2019/2020 Monitoring Period. During this process the system was tested as well as the Rscript additions reviewed both internally and externally by the State University of New York (SUNY). This testing and review process was outside of the original scope of works but was a great opportunity to demonstrate the value

of FIMS in a fully operational environment to perform the operational work flow, to generate estimates and store system generated documents and to test and refine the system documentation.

# 2 Activities undertaken to Complete Scope of Work

The method for the delivery of FIMS involved the following steps:

- Development a bespoke web front end and R Script execution framework with new functionality to allow the new workflow.
- Updating of the R Scripts and documentation to incorporate the regular ER Estimates to meet FCPF reporting requirements.
- Training of Ministry of Forestry staff in how to use the software and provide documentation to support its ongoing operation and use.
- Installation of the new software on the Fiji ITC infrastructure.

## 2.1 Operational System Software

The FIMS was built on the content management system (CMS) software Liferay. This is an open source CMS and incorporates the key functionality of:

- Simple document register
- Data set access
- R Scripts execution

Additional functionality incorporated into this FIMS includes:

- New R scripts and workflow to allow monitoring period reporting;
- Tracking through tags of R script, input data, and output data at time of the R Script Execution;
- Ability to re-run of tagged scripts, data states and check against associated tagged output;
- Ability to compare updated script execution against known data sets and output data;
- Export of specific format of output results to enable easy production of reports
- Capacity development and system design to facilitate PHP based Web applications to operate within the FIMS systems.

Some additional goals which were not able to be completed due to limitations posed by remote working were:

- Migration of other existing MSQL data tables to the NFMS database systems and servers.

These elements have been addressed somewhat through the adaptation of works flow and the documentation of processes to achieve desired outcomes.

## 2.2 Updating Rscript to produce ER Estimates

Under a previous contract, The University of Hamburg developed the methodology to estimate Fiji's Forest Reference Level. This methodology was implemented in Rscript.

Under this contract, this Rscript was extended to include the capability to generate estimates of Emissions Reduction for the Carbon Fund Reporting Period. The extension to the Rscript also resulted in some restructuring of the Rscript produced by The University of Hamburg for processing efficiencies and to support efficient testing and more detailed documenting of the calculations to support third Party review.

Finally, at the request of the World Bank the Rscript was sent to the State University of New York for a review and some suggestions for optimising the Monte Carlo implemented by the University of Hamburg were provided (see Section 4 – Next Steps).

As part of the deliverables of this contract the R Scripts were extended to generate ER estimates and all other figures required for the ER Monitoring Report, including risk buffer allocations and sensitivity analysis taking into account recently updated guidance on uncertainty and sensitivity analysis from the World Bank.

The team also engaged with the State University of New York (SUNY) in a review of the Rscript and some suggested changes as Next Steps are listed in Section 4.

The outputs generated from the Rscript were formatted into Tables consistent with the requirements of the FCPF ER Monitoring Report template. This enables Fiji to seamlessly transfer the Rscript outputs directly into the Monitoring Report.

The process of completing the calculations and transferring the estimates to the Monitoring Report are documented in the procedures as part of the final Deliverables; see Section 3.

The project delays did enable the team to fully test the FIMS during the development of Fiji's first ER Monitoring Report to the FCPF Carbon Fund. The Rscript, documentation and processes were systematically worked through in the development of the Draft ER Monitoring Report and any required adjustments were made.

This provided a great opportunity to test and adjust the system and provided a live environment to confirm the system is now fit for purpose.

## 2.3 Bespoke Front End Rscript Execution Framework

Fiji's FRL and ER calculation framework are executed in Rscript and draw of data inputs from the Ministry's database as well as data from external parties including Fijis Plantation companies. FIMS has been developed to enable these calculations to be conducted in a user-friendly web interface with links to a document management system to implement document management and version control processes.

## 2.4 Installation of Software on Fiji's ITC Infrastructure

First the hardware will be installed in the data centre and then the FIMS REDD+ Unit/FRAC technical staff will install the FIMS software.

As part of the installation of the hardware server integration into the ITC data centre. The ITC will provide the following:

- Installation of Microsoft 2019 Server

- Docker hosting which includes the ability to host linux images

- Provision of SSL certificates for the reddplus.gov.fj domain

- 2 public IP addresses and associated DNS records

Once the hardware is operational the ITC team will provide rack location details, ip addresses for both public in internal LAN access as well as RDP access.

The installation of the FIMS software will include the following extra software sub-systems:

- ODK Central (An upgrade to ODK collect)
- Updated Postgresql and PostGIS databases services
- Latest GeoServer

## 2.5 Training and Operational Documentation

Two separate delivery training programs were completed as part of this Project:

1. System Administration training to ensure the system could be uploaded and integrated onto Fijis systems. A series of three, 3-hour workshops were held with ITC professional with the Ministry of Forestry. The focus of this training was to support the remote installation of FIMS on Fiji's government systems and to build capacity in running and maintaining the system. The list of participants is provided as an Annex to this report.

2. System user training was also conducted over three workshop sessions. The focus of these sessions was to demonstrate the core feature and functionality of the FIMS in the context of delivering the Measurement, Reporting and Verification requirements of the Carbon Fund. The list of participants is provided as an Annex to this report.

Documentation produced during this Project includes a FIMS Operational Manual and Standard Operating Procedures describing the steps required to run the calculations and store system outputs to meet the requirements of the Carbon Fund. These documents have been generated to be consistent with other documentation and Standard Operating Procedures developed by World Bank Consultants.

A series of power point presentations were also produced to deliver the training and capacity building series. These materials, along with all other documentation relevant to the generation of ERs for this current Carbon Fund Monitoring Period have all be uploaded to FIMS prior to installation in Fiji.

# 3 Final Deliverables Provided

The following results were anticipated to be achieved from this contract:

- Fiji MSD staff can independently operate the R Script calculations for future monitoring periods.
- Calculations for FRL and ER estimates are repeatable and consistent.
- The format of outputs form the integration framework are consistent with available monitoring report templates of the FCPF.
- instruction on how to integrate any future changes will form part of the documentation provided.

To achieve these results the following final deliverables for this project, which fall into four categories, where delivered.

## 3.1 Fiji's Forest Information Management System Software

**Requirement:** Software and tools with a user-friendly interface to integrate and operate the FRL and ER calculation R script against collected data sets.

**Deliverable:** FIMS Software platform

**Location:** Installed on the Fiji Ministry of Forestry ITC systems

**Desired Outcome Supported:**

- Fiji MSD staff can independently operate the R Script Calculations for future monitoring periods.
- Calculations for FRL and ER estimates are repeatable and consistent.
- The format of outputs form the integration framework are consistent with available monitoring report templates of the FCPF.

## 3.2 Rscript Updates

**Requirement:** Update the R scripts and documentation to calculate the emission reductions for each monitoring period

**Deliverable:** Modularised, updated FRL, created new methodology for ER calculations, sensitivity analysis, supported third party review of Rscript

**Location:** Embedded in the FIMS system but also able to be run on R Studio

**Desired Outcome Supported:**

- Fiji MSD staff can independently operate the R Script Calculations for future monitoring periods.

- Calculations for FRL and ER estimates are repeatable and consistent.
- The format of outputs form the integration framework are consistent with available monitoring report templates of the FCPF.

## 3.3 Training

**Requirement:** Conduct staff training on the running and management of the NFMS Integration Tool.

**Deliverable:**

- REDD+ Unit/FRAC technical staff operational training
- System Administrator training

**Desired Outcome Supported:**

- Fiji MSD staff can independently operate the R Script Calculations for future monitoring periods.
- Calculations for FRL and ER estimates are repeatable and consistent.
- The format of outputs form the integration framework are consistent with available monitoring report templates of the FCPF.

## 3.4 Documentation

**Requirement:** Develop Standard Operating Procedure/s (step by step instructions) for running NFMS Integration Tool and generating estimates.

**Deliverable:**

- Documentation of the ER methodology
- Standard operating procedure for running the ER Estimation Process in FIMS
- FIMS User Manual
- Operational Staff Workshop Training Materials
- System Administrator Workshop Training Materials

**Location:**

**Desired Outcome Supported:**

- Fiji MSD staff can independently operate the R Script Calculations for future monitoring periods.
- Calculations for FRL and ER estimates are repeatable and consistent.

- The format of outputs form the integration framework are consistent with available monitoring report templates of the FCPF.

**Table 1: Summary of specific elements of note in the set of deliverables**

# 4 Suggested Next Steps

As part of updating and extending the infrastructure and processes of the FRAC this would be a good time to have a review and discussion with the MSD staff to identify other GIS software needs.

These new systems could then be added to the infrastructure that hosts the FIMS sotware.

# Appendices

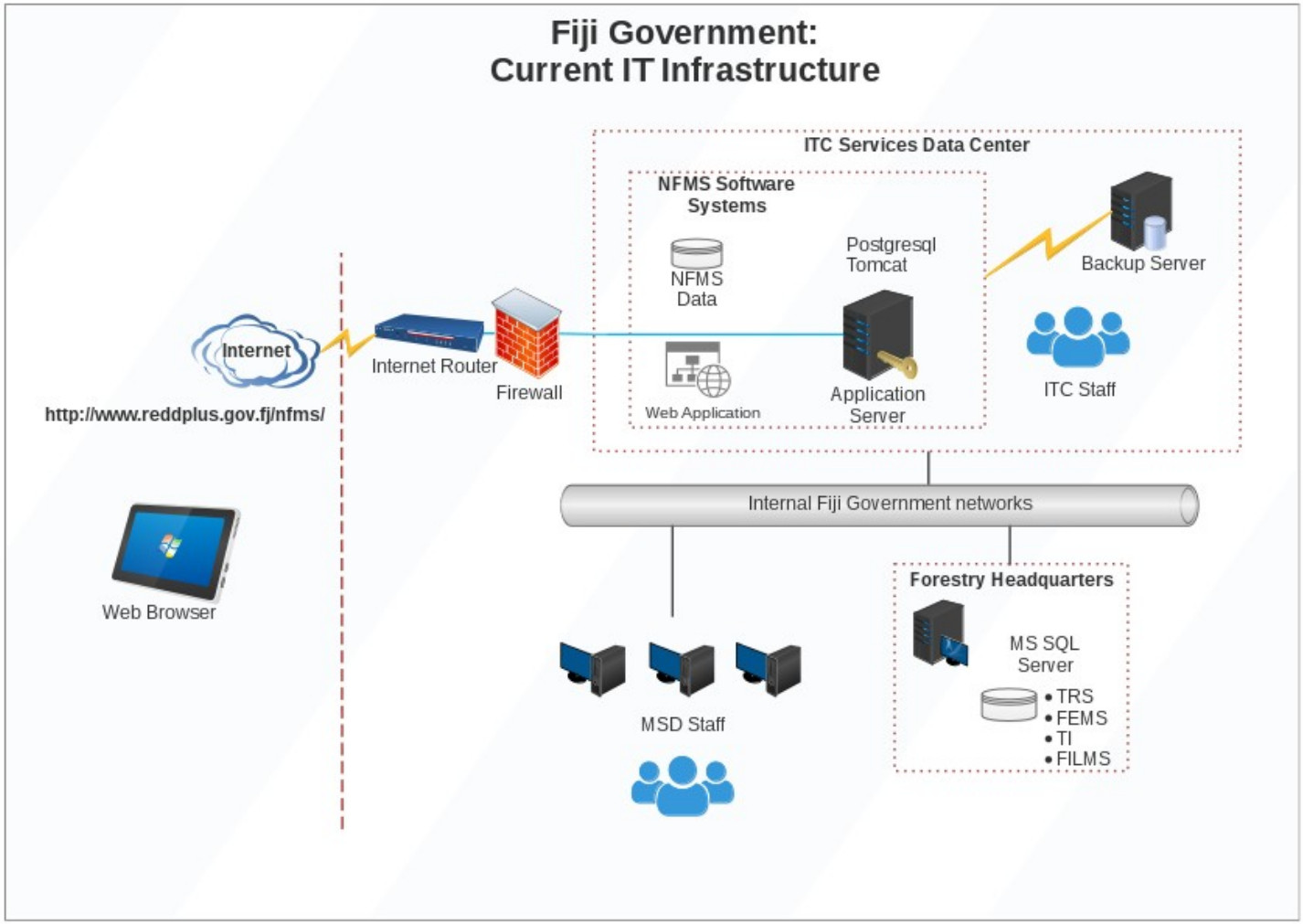
**Appendix: System Administrator Training**

| Attendees | Department | Day 1 | Day 2 | Day 3 |
|---|---|---|---|---|
| Timoci S. Lagataki <tlagataki@govnet.gov.fj> | FRAC | Y | Y | |
| Mesake Masi (mesakemasi@gmail.com) | FRAC | Y | | |
| Inoke Erenatau (inoke.erenatau@govnet.gov.fj) | FRAC | | | |
| Ananaiyasa Diri (akaloucava@govnet.gov.fj) | FRAC | | | |
| Tomasi Chan <tomasi.chan@itc.gov.fj> | ITC | Y | Y | |
| Shaazreen Bi (shaazreen.bi@itc.gov.fj) | ITC | Y | | |
| Ro Han Prahalad (rohan.prahalad@itc.gov.fj) | ITC | Y | Y | |
| Colin Shackley ( colin.shackley@itc.gov.fj) | ITC | Y | Y | |

**Appendix: System User Training**

| Attendees | Department | Day 1 | Day 2 | Day 3 |
|---|---|---|---|---|
| Iiai Tulele <tulele.ilai@outlook.com> | REDD+ Unit | Y | Y | Y |
| Vili Tupua , | REDD+ Unit | Y | | Y |
| Reama Naco | REDD+ Unit | Y | Y | |
| Semisi Tuicake <semisituicake@gmail.com> | FRAC | Y | Y | Y |
| Sonu Dutt <sonudutt.frac@gmail.com> | FRAC | Y | Y | |
| Anare Pisaimoce <apisaimoce.frac@gmail.com> | FRAC | Y | Y | |
| Timoci S. Lagataki <tlagataki@govnet.gov.fj> | FRAC | Y | Y | |
| Randy Hamilton | US Forest Service | Y | Y | |

**Appendix - MSD IT infrastructure**



**Appendix – Electronic Resources and Materials Provided**

| Description | Date or Version | Details/Notes | Who provided it | Filenames |
|---|---|---|---|---|
| Fiji FRL calculation code | 5 Oct 2019 | R Script for calculation of Fiji FRL | Carly Green | fiji_frl_all_R_code.R |
| Fiji FRL R script Documentation | 5 Oct 2019 | Fiji Forest Reference Level R Markdown files written by Philip Mundhenk 2019-10-04 | Carly Green | Fiji_FRL_R_documentation.zip |
| Fiji's Forest Reference Level Update | Friday 14 th June, 2019 — 07:17 | This document provides another update of Fiji's Forest Reference Level (FRL) using the updated Accuracy Assessment Results | Carly Green | Fiji_FRL_update_June_14_2019.pdf |
| Accuracy Assessment Results | 13 Jun 2019 | The most recent accuracy assessment data used in the FRL, including the data from Vanua Levu (sent to Philip Mundhenk by Rohan Sadler; June 13, 2019; 22pm). | Carly Green | area_change_2006_2016.csv |
| ERPD and Project documentation | Jun 2019 | | Carly Green | Fiji_Forest_Reference_Level_2006-2016.pdf<br>ER-PD Fiji MASTER_v8_clean16619.docx<br>FCPF Emission Reductions Monitoring Report_2019_3.docx |
| SOP template [Note about the other project] | To Be Confirmed | These will be collected when they are available. | TBC | |
| Any calculations/excel spreadsheets relevant to the calculation of the ERs | To Be Confirmed | These will be collected when/if required | TBC | |
| Database data or schema | 27 Mar 2020 | SQL dump of data and schema | Timoci | nfmsbackup.sql.tgz |

| Description | Date or Version | Details/Notes | Who provided it | Filenames |
|---|---|---|---|---|
| with extracts of typical data | | | Lagataki | |
| Source Code for Fiji NFMS Web Application | | Backend<br>Fiji-Rfi-WebFrontend.sln<br>RCaller<br>r-scripts<br>WebFrontend | Timoci Lagataki | FijiNFMS.tgz |
| NFMS Application Binaries | | nfms test install-package<br>ODK Aggregate<br>r_packages_for_forest<br>TRS.bak | Timoci Lagataki | fiji-nfms-apps.tgz |
| NFMS Operational IT infrastructure, administration and any required software licences | | | Timoci Lagataki | 1. FIJI NFMS Database_FIJI NFMS Database_Cor.docx<br>2. NFMS client desktop setup_V1.0_PN_Cor.docx<br>3. NFMS database maintenance_V2.0_Cor.docx<br>4. ODK Aggregate maintenence_V1.0_Cor.docx<br>5. ODK collect setup for survey devices_V1.0_Cor.docx<br>6. NFMS server installation_V3.0_Cor.docx<br>7. NFMS web application maintenance_V2.1_Cor.docx |

**Appendix – Issues for clarification during the work**

| # | Related work | Issue Description | Notes |
|---|---|---|---|
| 1 | Operational System Software | Investigation into options for deployment and installation of software remotely | |
| 2 | Staff Training | Options for training of Fiji staff with a 1 to 1 set 5 x 1 hour tutorials | |
| 3 | Staff Training | Options for delaying training until Sep/Oct to collaborate with other SOP work and training | |
| 4 | ER Estimate Calculations | Uncertainty and Accuracy Assessment on Activity Data to be recalculated or carried forward from FRL | |
| 5 | R Scripts | Significant Figures to be used in values taken from Baseline, ie Upland and Low Land EF | |
| 6 | Reporting | Significant Figures to be used in Estimates and values in output tables. | |
| 7 | Reporting | Internal Reporting of sub national values (Will Input data be divided into sub national categories) Not all input values to the FRL are divided into sub national categories. | |
| 8 | R Scripts | Fuel Wood is currently not included in calculations | |
| 9 | R Scripts | Inconsistency in the calculation of Mean Annual Carbon Increment (AR) in the ERPD and the value written in the R Script. These do not currently match. | |

| # | Related work | Issue Description | Notes |
|---|---|---|---|
| 10 | R Scripts | The R Script calculation has a “fix” for softwood harvested area. It seems that the values for the reference period where not always available and so it reverse calculated the areas from the harvested logs. | The yearly ER estimates will expect the harvested area for softwood to be available. |
| 11 | R Scripts, ER Estimate Calculations | The FRL used an offset calculation method for each year of growth. (It used a sequence starting at 0.5 and increasing by 1 till 10.5 for the 11 year reference period). The 0.5 comes from the assumption that the trees only grow for 6 months in the year the area was planted. | ER estimates may be calculated using one of the following different offsets.<br><br>years of growth = sequence offset + (current year – year planted)<br><br>Either<br><br>- Assume the plantation was established on Dec 31 of the year so there is no growth in the establishment year (seq. offset = 0)<br><br>- Continue the FRL method which assumes the plantation was establish on June 30 of the year and so there is 6 months of growth in the establishment year (seq. offset = 0.5)<br><br>- Assume the plantation was established on Jan 1 of the year so there is 12 months of growth in the establishment year (seq. offset = 1) |
| 12 | R Scripts, ER Estimate Calculations | The FRL calculated the number of 12 month intervals as 11 for the reference period of 2006 to 2016. This considers the date range as inclusive of each end i.e. Jan 2006 to Dec 2016 which has 11 sub periods of 12 months. | The yearly ER estimate will consider the period identified by a year (i.e. 2018) as one period of 12 months. The data supplied to the calculations will be expected to represent all the activities and changes that happened in just a single period of 12 months and identified with a single year. |