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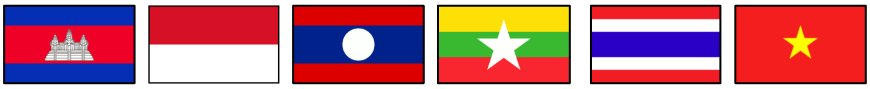
ReCaREDD Regional Workshop Southeast-Asia

Approaches for monitoring of deforestation and forest degradation in the context of REDD+ using Remote Sensing - Methods and Tools
Bangkok, 10-13 July 2018



including feedback from post-workshop stakeholder meetings (Sep 2018)

organized by the
European Commission - Joint Research Centre

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1. Context

The ReCaREDD[1] (**Re**inforcement of **Ca**pacities for **REDD**+) project is hosted by the European Commission's Joint Research Centre (JRC), funded by the European Commission's Directorate-General for International Development and Cooperation (DG DEVCO). The main goal of the project is to enhance the capacities of institutions in tropical partner countries to assess and report on deforestation and forest degradation in the context of REDD+, in a reliable and cost-efficient manner. Specific objectives are to develop and share appropriate monitoring methods and software tools using satellite remote sensing data, and to provide direct assessments of the status and evolution of tropical forest cover in support to forest policies and national or international negotiations on emission reductions.

In continental Southeast Asia the ReCaREDD project has established direct collaboration with partners in Cambodia, Laos and Vietnam ('focus countries'), where methodologies for forest monitoring and new Sentinel-2 satellite imagery are being tested in collaboration with national partner organizations. The JRC has implemented a set of national workshops and training sessions, focusing on methodologies for assessing forest canopy disturbance as indicator for degradation. Several field surveys have been conducted with colleagues from the partner institutions.

Also other countries of the region ('associate countries') can benefit from the project: (i) all data, methodologies and tools produced in the context of ReCaREDD will be freely shared, and (ii) case by case collaboration is implemented on selected topics. For instance ReCaREDD has assisted national forest institutions in Myanmar and Nepal by providing Sentinel-2 satellite data for the whole country in 2015/2016.

In addition, the ReCaREDD component on 'Prototyping a Regional Forest Observatory in continental Southeast Asia' (RFO-SEA), offering a platform for free access and sharing of information related to forestry and REDD+, ultimately addresses all countries in the region of Southeast Asia.

2. Objectives

The main objectives of the regional workshop were

- to share ReCaREDD results, products and tools among a larger number of countries in the SE-Asia region, i.e. reaching out to those countries not continuously involved in the project in the past, like Indonesia, Myanmar and Thailand ('ReCaREDD associated countries'),
- to provide an update on the developments taken place since national workshops of 2017,
- to present and demonstrate the functionalities of the Regional Forest Observatory to a broader number of country representatives,
- to foster information exchange and discussion between the participants from different countries of SE-Asia,
- to inform organizations and projects active in the region in the forestry sector and REDD+ (e.g. FAO, RECOFTC, SERVIR-MEKONG),
- to meet with stakeholders from regional organizations & projects.

[1] Full title: 'Strengthening national and regional capacities for reporting on the mitigation actions of the forest sector'

3. Program of Regional Workshop

This mainly technical workshop consisted of two days of presentations and of two days of training sessions. Focus has been on methodologies and tools developed by the JRC in the context of the ReCaREDD project for monitoring and reporting forest change, particularly forest degradation. The topics included (i) assessing deforestation based on the JRC 'Roadless Forest' data set, (ii) mapping forest degradation processes based on the canopy disturbance index (ΔrNBR) developed by the JRC and (iii) the recent version of the JRC IMPACT Tool, with two embedded modules for calculating carbon emissions. Furthermore, there has been a detailed presentation and demonstration of the RFO-SEA. In addition, there were external presentations from FAO-RAP, V4MF and Mekong SERVIR projects (Tab1 and 2).

Table 1: Program Workshop Days 1 and 2

DAY 1	Arrival / Registration	
9.00 - 9:30	Welcome	EU Del, JRC
9:30 - 10:00	Overview ReCaREDD project	JRC
	ReCaREDD experiences on forest monitoring by satellite imagery	
10:30 - 11:00	'Roadless Forest Map' – pan-tropical forest change mapped based on Landsat archive	JRC
11:00 - 11:30	Monitoring forest degradation by Remote Sensing - a challenge	JRC
11:30 - 12:00	Monitoring forest canopy disturbance /degradation based on the Δ-rNBR index	JRC
12:00 - 12:30	Discussion	JRC
	The Regional Forest Observatory	
14:00 - 14:30	The Regional Forest Observatory-Southeast Asia (RFO-SEA)	Forest Carbon
14:30 - 15:00	RFO-SEA Demonstration & Discussion	
	Regional activities	
15:30 - 16:00	From reference levels to results reporting: support provided in Asia & Pacific region	FAO-RAP
16:00 - 16:30	Collaborative development of a regional land-cover monitoring system	SERVIR-Mekong
16:30 - 17:00	Discussion	
DAY 2	*Regional activities (cont'd)*	
8:30 - 8:45	Introduction day 2	JRC
8:45 - 9:15	The 'Voices for Mekong Forests' (V4MF) Project - potential links to the RFO-SEA	RECOFTC
	Country Presentations	
9:15 - 9:30	Introduction	JRC
9.30 - 10:00	National forest monitoring and reporting in Indonesia	DGCC/MEF
10:30 - 11:00	National forest monitoring and reporting in Laos	FIPD / DoF
11:00 - 11:30	National forest monitoring and reporting in Cambodia	GDANCP
11:30 - 12:00	National forest monitoring and reporting in Vietnam	FIPD
13:30 - 14:00	National forest monitoring and reporting in Myanmar	MoNREF
14:00 - 14:30	National forest monitoring and reporting in Thailand	RFD
14:30 - 15:00	Discussion	
	JRC IMPACT Tool & SENTINEL 2	
15:30 - 16:15	JRC IMPACT TOOL - Overview (JRC)	JRC
16:15 - 16:30	Update on SENTINEL-2	JRC
16:30 - 17:00	Discussion	

Table 2: Program Training days 3 and 4

DAY 3	**Training**: ***Δ-rNBR index to support forest degradation assessment (GEE-based tool)***	JRC
8:30-10:00	Presentation of functionalities of Δ-rNBR GEE tool	
10:30-12:00	Exercise - General parameters for the Δ-rNBR tool	
13:30- 15:00	Exercise - Specific parameters for the Δ-rNBR tool; Map Export, Post-processing steps (GIS) for forest degradation assessment	
15:30-17:00	Individual practicing	
short presentation	Introduction to the Operational Logging and Degradation Monitoring System 'OLDM' (using ΔrNBR and Planet imagery)	*Aruna* Technology
DAY 4	**Training**: ***JRC IMPACT Tool***	JRC
8:30-10:00	Import S2, Classification, Raster editing	
10:30-12:00	Raster Calculator, Segmentation, Vector editing	
13:30- 15:00	IMPACT tool modules supporting the estimation of forest change and related emissions, based on existing forest and forest disturbance maps	
short presentation	Mangrove Monitoring in Thailand (time series analysis)	KMUTT
15:30- 17:00	Individual practicing	
	Closing	

4. Main Topics of Regional Workshop

4.1. Monitoring forest cover in SE-Asia based on the JRC global map of evergreen forest and forest change

The global forest cover map produced by the JRC is based on the 36-years archive of Landsat satellite imagery (Vancutsem and Achard, 2016[2]). The generation of this map has been launched by the 'Roadless Forest' project' (http://forobs.jrc.ec.europa.eu/roadless/), it has been completed and continuously up-dated in the context of ReCaREDD. An extract of the SE-Asia region has been presented during the workshop and has been used for training.

The forest cover map provides globally thematic information on the extent of evergreen tropical forest cover and long-term historical change at 30m spatial resolution. The spectral behavior of each individual pixel can be traced during all available images available in the Landsat archive (1982-2017), permitting the monitoring of forest change and particularly deforestation at an annual basis or for defined periods. The higher frequency of Landsat acquisitions in recent years has significantly improved the consistency of the map. A typical legend that can be retrieved from the data set is displayed in Fig. 1.

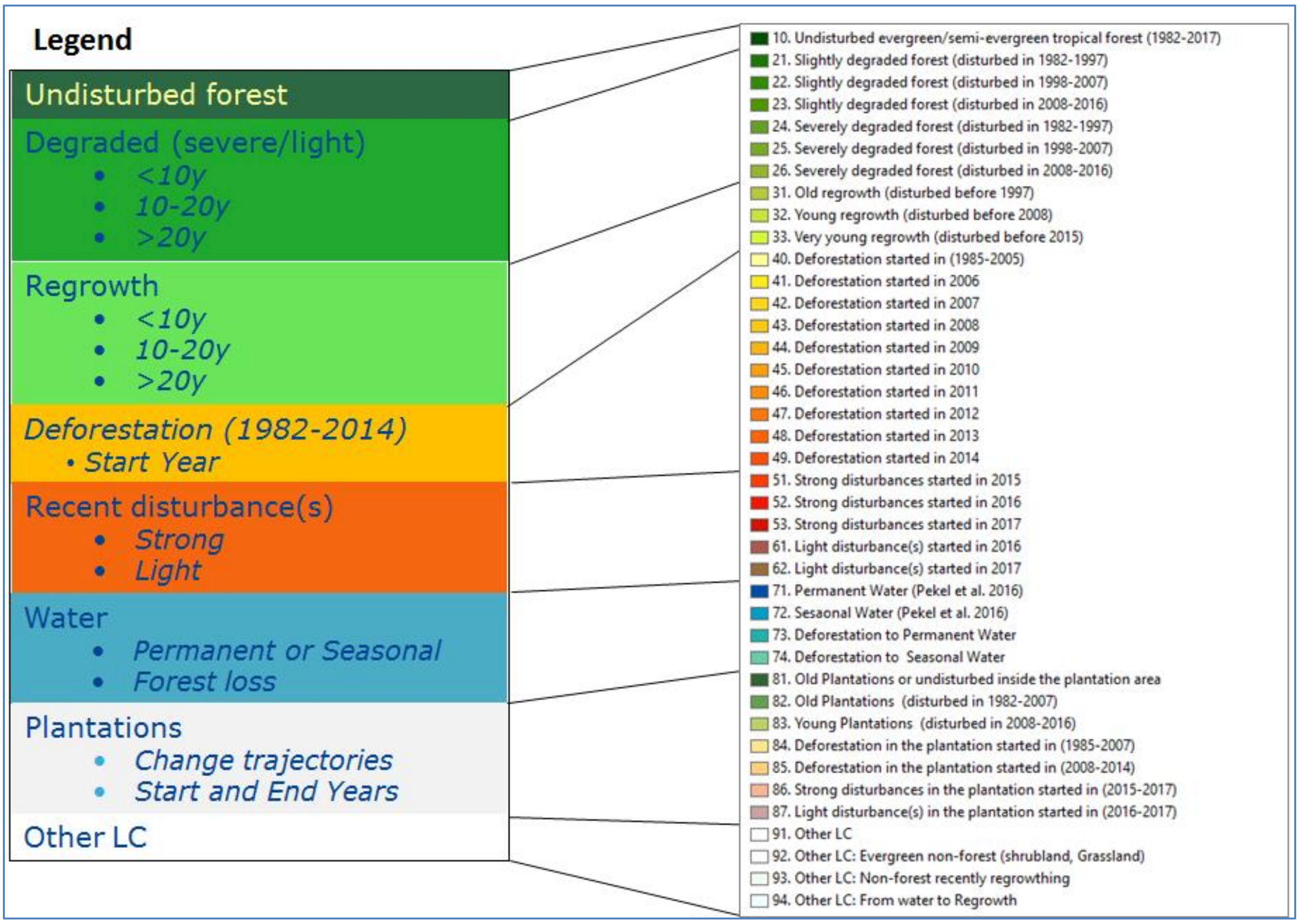

Fig.1: Legend retrieved from the 'Roadless Forest' data set – one possible grouping of individual classes

[2] Vancutsem Ch. & F. Achard, 2016. Mapping Intact and Degraded Humid Forests over the Tropical Belt From 32 Years Of Landsat Time Series. *Paper 2034 - Session title: Tropical Forest and REDD+ 1. ESA living planet symposium 2016*

Examples of large-scale deforestation in Cambodia mainly since 2005 and of smaller-scale forest change in western Kalimantan are displayed in Fig 2.

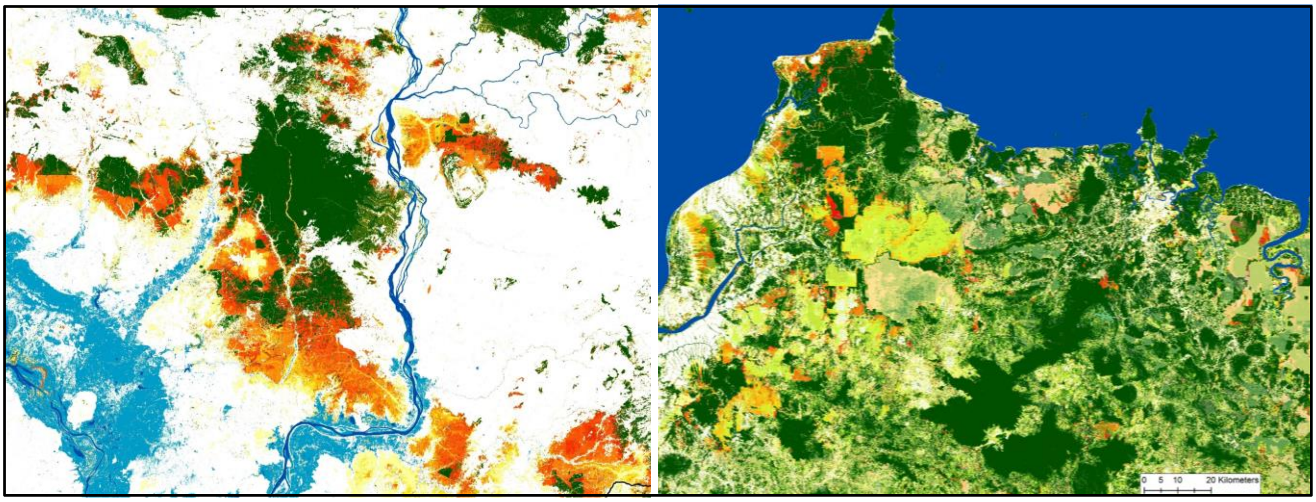

Fig. 2: Deforestation in central Cambodia (left) and Kalimantan (right)

The mapping approach used for generating this global product is basically classifying 'disruption' events in forest canopies at the pixel level for each individual satellite image. Then the sequence of these single-date disruptions over the full period are used for identifying the change trajectories, i.e. undisturbed evergreen forest, from evergreen forest to degraded forest, deforested land, forest regrowth, recent disturbances and other land cover:

- *Undisturbed evergreen forests* are defined as evergreen forest cover without any disruption observed over the 36-year Landsat record.
- *'Degraded' forests* are separated from *deforested land* mostly based on the duration of the disturbance, i.e. if the disturbance is observed less than 2.5 years (900 days), it is considered as 'degraded' forest.
- A *forest regrowth* is a two-phase transition from evergreen forest to first deforested land and then to forest regrowth (observed at least over the period 2015-2017 to accurately discriminate forest regrowth from agriculture fields).
- *Recent disturbances* correspond to disturbances that initiated after 2015 but cannot yet be attributed to long-term deforestation, owing to the limited historical period of observation.

In addition, sub-classes are identified using ancillary information: conversion from evergreen forest to tree plantations and to water surface. Each disturbed pixel was characterized by the timing of the disruption events, i.e. short and long duration, deforestation year, and age of the regrowth (Fig.1).

For ReCaREDD partners in Southeast Asia, where national forest maps exist in all countries, the JRC map could serve as general independent reference, for comparing to and updating of national maps, but also for reproducing forest cover extent for a desired reference year or forest change for a specific reference period.

4.2. Mapping forest canopy disturbance as basis for assessing potential forest degradation, based on the 'ΔrNBR' canopy disturbance index

A main focus of the workshop was on the detection of forest canopy disturbance within evergreen forest canopies ('forest remaining forest'), resulting for instance from the tree removal, felling damages or from logging trails and leading - depending on the 'definition' - potentially to forest degradation. The approach

developed and introduced by the JRC is based on the 'Normalized Burn Ratio' (NBR) and detects change over defined time periods at pixel and sub-pixel level (Langner et al. 2018[3]).

The application of the ΔrNBR methodology has been the topic of one full day of training provided in the context of this workshop.

For generating the ΔrNBR product there are three main steps of image processing:

1. Calculating the 'Normalized Burn Ratio': $(NBR = \frac{NIR-SWIR_2}{NIR+SWIR_2})$
2. 'Self-referencing' based on the median value derived within a defined spatial kernel: $(rNBR = NBR_{n\_med} - NBR)$
3. Differencing of referenced NBR values of two dates /periods: $(\Delta rNBR = rNBR_{t2} - rNBR_{t1})$

Particularly when analysing the ΔrNBR index for time periods, e.g. including all image acquisitions available in the Landsat or Sentinel-2 archive for whole seasons or years (Fig. 3), forest canopy disturbance can be detected at much higher consistency and reliability levels, capturing also disturbances occurring only occasionally. The index can serve in such cases as indicator for potential 'forest degradation'.

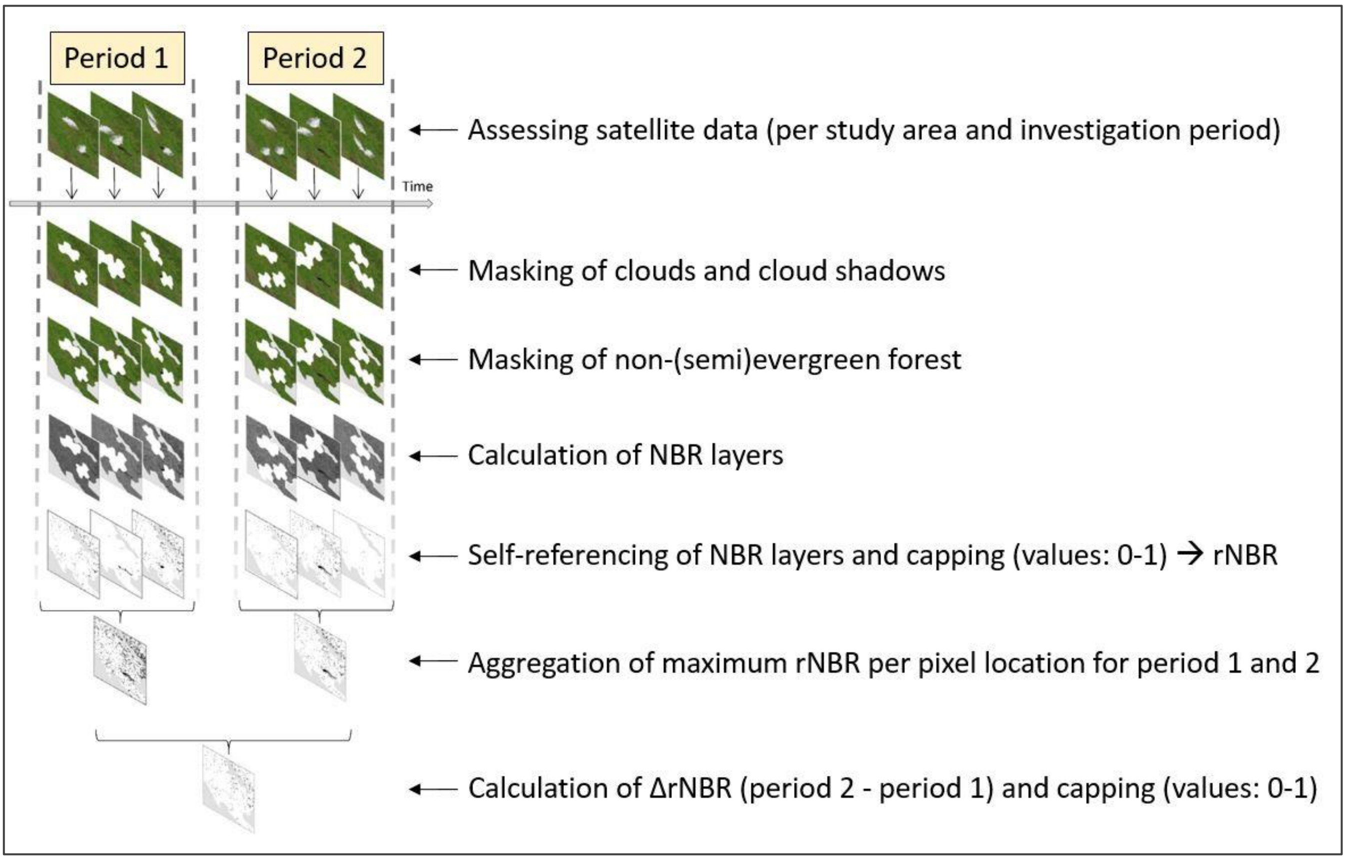

Fig. 3: Processing steps for deriving the *ΔrNBR product*

[3] Langner A, Miettinen J, Kukkonen M, Vancutsem C, Simonetti D, Vieilledent G, Verhegghen A, Gallego J, Stibig H-J. 2018. Towards Operational Monitoring of Forest Canopy Disturbance in Evergreen Rain Forests: A Test Case in Continental Southeast Asia. Remote Sensing. 10, 4, 544, doi:10.3390/rs10040544

The training on the ΔrNBR methodology included the use of the Google Earth Engine (GEE) script developed by the JRC, enabling the user to calculate the index across any area of interest and any time period, based on the full Landsat and Sentinel archive. A specific GEE user-interface has been designed (Fig. 4), allowing the user to choose the main parameters from a simple drop-down menu, without the need of text-editing in the GEE script, which was highly appreciated by the workshop participants.

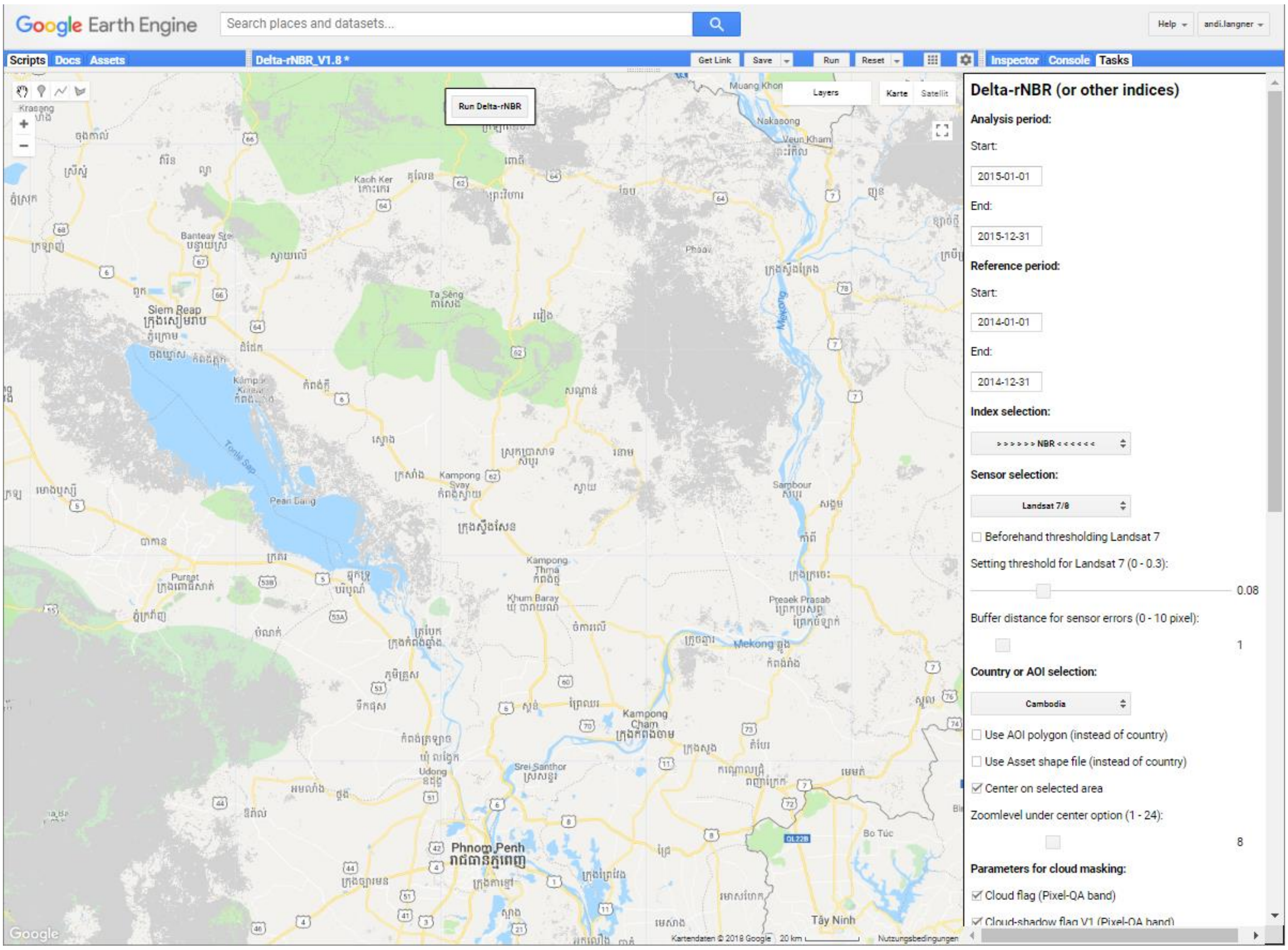

Fig. 4: GEE user-interface developed for calculating the *ΔrNBR*

An example of ΔrNBR results is displayed for locations in north-eastern Cambodia (Fig. 5).
Newly detected canopy disturbance patterns for the periods December 2017 to February 2018 displayed in red colour, most recent canopy disturbances detected during the period March to June 2018 are displayed in blue colour. The comparison of the ΔrNBR results to recent SENTINEL-2 satellite imagery of higher spatial resolution (Fig.5 b & c) demonstrates the potential of the approach.
Note: The ΔrNBR method detects forest cover disturbances occurring within an observation period defined by the user; change occurring for instance before that period is in such case not reflected by the ΔrNBR result, even if still visible on satellite imagery.

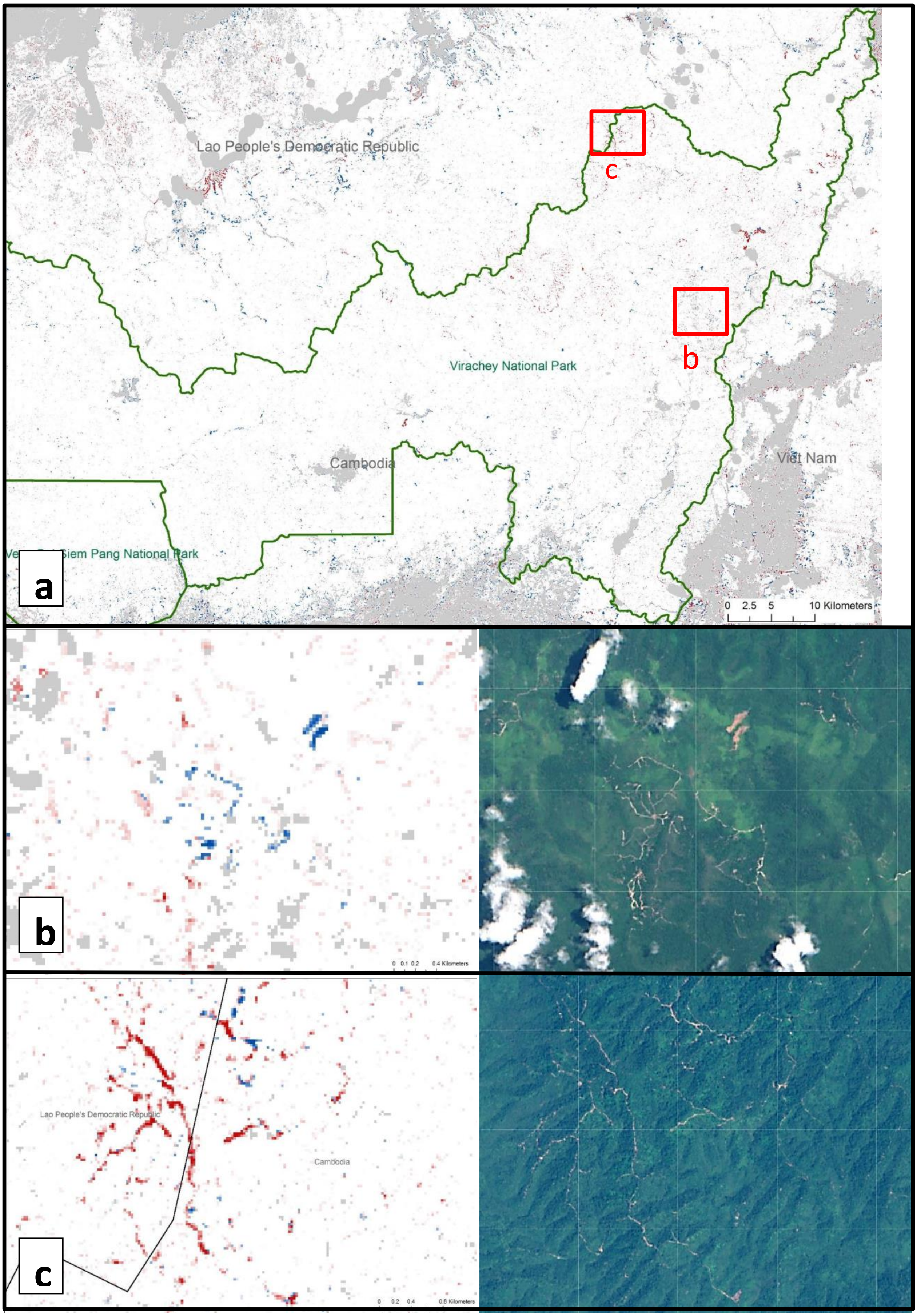

Fig. 5: Examples of forest canopy disturbance detected by ΔrNBR index based on Landsat 8 imagery in north-eastern Cambodia: (a) ΔrNBR map provincial scale, (b)+(c) ΔrNBR map local scale and reference images of higher spatial resolution (Sentinel-2 imagery); legend: white=forest, grey=non-forest, red=disturbance Dec 2017-Feb 2018; blue= disturbance Mar-Jun 2018.

A further task of the training was to transform the original ΔrNBR index results into a map, suitable for estimating the area affected by forest degradation. As the ΔrNBR index indicates forest canopy 'disturbance' in general, a visual/manual cross check and a three-step validation procedure has been considered feasible in order to ultimately move from a forest canopy 'disturbance' to a map on potential 'forest degradation':

Step 1. Removing 'noise' by defining a minimum threshold for the ΔrNBR index and masking all values below that value as 'noise'. In addition, spatially isolated and single pixels could be removed by a spatial filtering process.
Step 2. Broad separation of human impact from natural canopy disturbances (e.g. bamboo dying) and other artefacts (e.g. unmasked clouds). This has to be done mainly based on expert knowledge and results in a stratification layer containing the remaining human forest disturbance patterns.
Step 3. Applying criteria of a definition of 'forest degradation'. This could for example result in a removal of short-lasting impact or of logging patterns, in case the definition does not consider 'forest management practices' (e.g. 'reduced impact logging') as 'forest degradation'.

This procedure could serve as a 'workable' approach for 'estimating' the forest area affected by 'degradation'. It is based on a largely automated process, and remains – if post stratification is well documented - transparent, consistent and repeatable, thus allowing the comparison of different observation periods. The approach would capture main patterns of forest degradation rather than classifying correctly each individual isolated pixel, therefore area estimation in broader intervals of 5% or 10% were considered an option.

Three further options were discussed for estimating the area affected by forest degradation in an operational way:

1. Buffering each pixel (e.g. 60 m radius), assuming that also direct neighbourhood is affected by degradation; the method would increase the area of degradation in comparison to a direct count and could simulate the concept of a 'minimum mapping unit'.
2. Using a regular grid (e.g. 300m x 300m) and assigning different disturbance intensity classes by counting degraded pixels per grid unit (Fig. 6). Apart from the possibility to define a minimum mapping unit, this approach could allow tracing degradation within 'stable' mapping units (=grid cells) through time.
3. Overlaying the ΔrNBR index results with an existing polygon-based forest map and classifying a polygon as 'degraded' when reaching a certain threshold in terms of percentage of disturbance. This approach could be a way for integrating most existing national forest maps.

It should be noted, that the ΔrNBR index as presented so far generates change information for a pre-defined time period, i.e. 'activity data'. The index does not per-se provide the overall status of a forest in terms of total degraded area. One option for approaching the mapping of the total forest area affected by degradation in the past could be the analysis of long-term time series of ΔrNBR data, supporting the assessment of the degradation / regeneration status of a forest (Fig. 7).

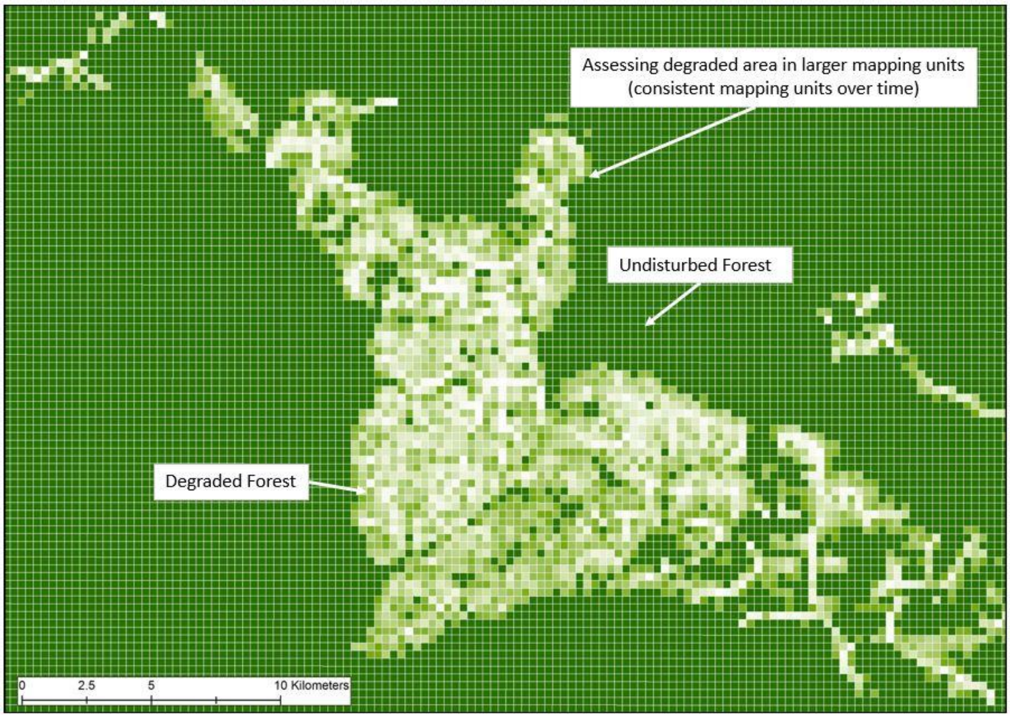

Fig. 6: Disturbance intensity classes assigned per grid-cell based on ΔrNBR pixel count

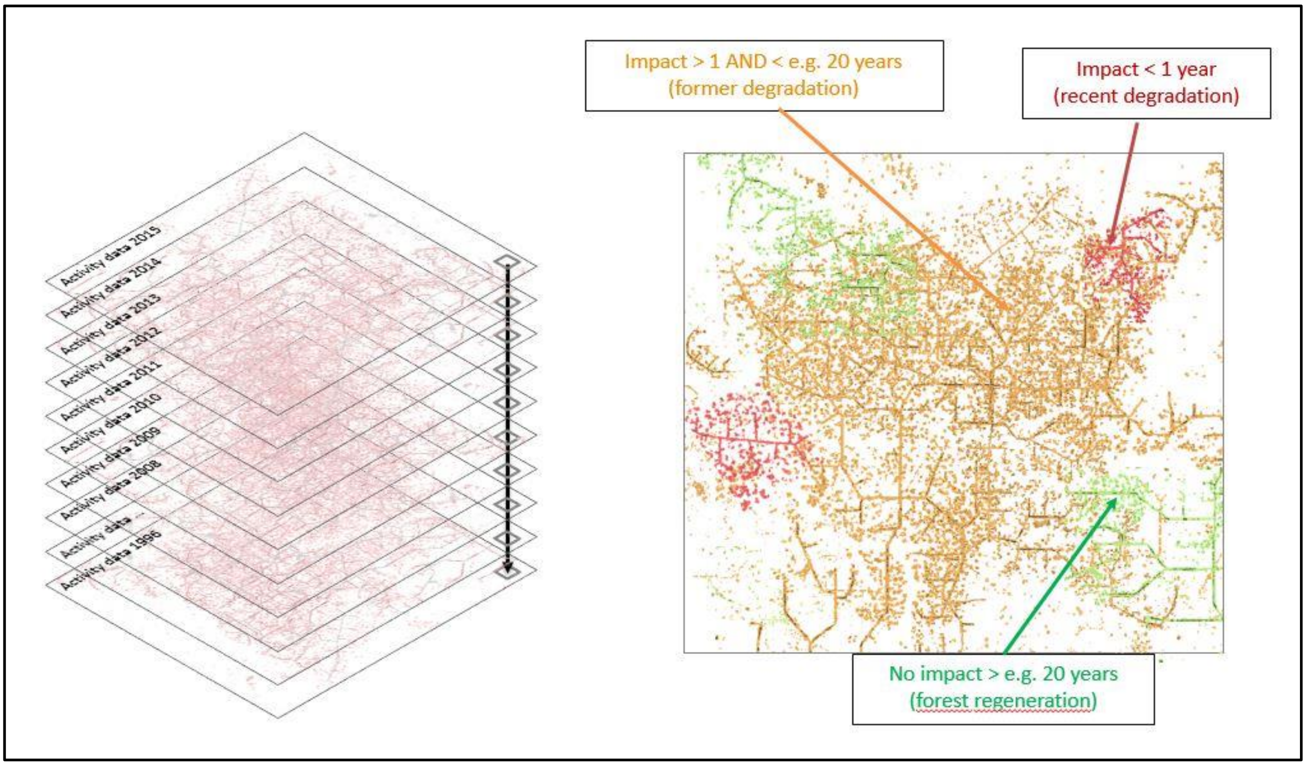

Fig. 7: Analysis of long-term time series of ΔrNBR data

4.3. The Regional Forest Observatory - Southeast Asia (RFO-SEA)

A detailed presentation and demonstration of the RFO-SEA (Regional Forest Observatory-South East Asia) was given by J. Ferrand (Fig. 8). The RFO-SEA project was implemented as ReCaREDD component by an international consortium (project leader J. Ferrand, end of contract March 2018). The objective was to establish a prototype of a regional platform (data base, website) for freely sharing and accessing information related to forestry and REDD+ in Southeast Asia. The RFO-SEA prototype offers through its *'Geoportal'* access to regional Sentinel-2 mosaics and to a number of land and forest cover maps (global, regional, national scale) and other geographical data sets. The '*Information Repository*' contains reports and documents related to forests and REDD+ in the region, including for example information on drivers of forest change, REDD+ submission documentation, allometric data reports and other. The '*National Summaries*' provide information on forest cover and status in the countries.

Particularly the geoportal provides a regional view on forest cover in Southeast Asia. Apart from national forest maps, one can find regional and global forest data sets. The latter two permit for example national forestry departments to compare to and possibly to update their national maps. Major forest change processes can often be depicted from regional or global data sets, as they are usually updated in shorter time intervals. Regional maps may further provide an independent reference for addressing cross-country issues.

J. Ferrand presented the findings of a regional 'roadshow' in six Southeast Asian countries, performed from May to June 2018 and promoting the final version of the RFO-SEA prototype in the region.

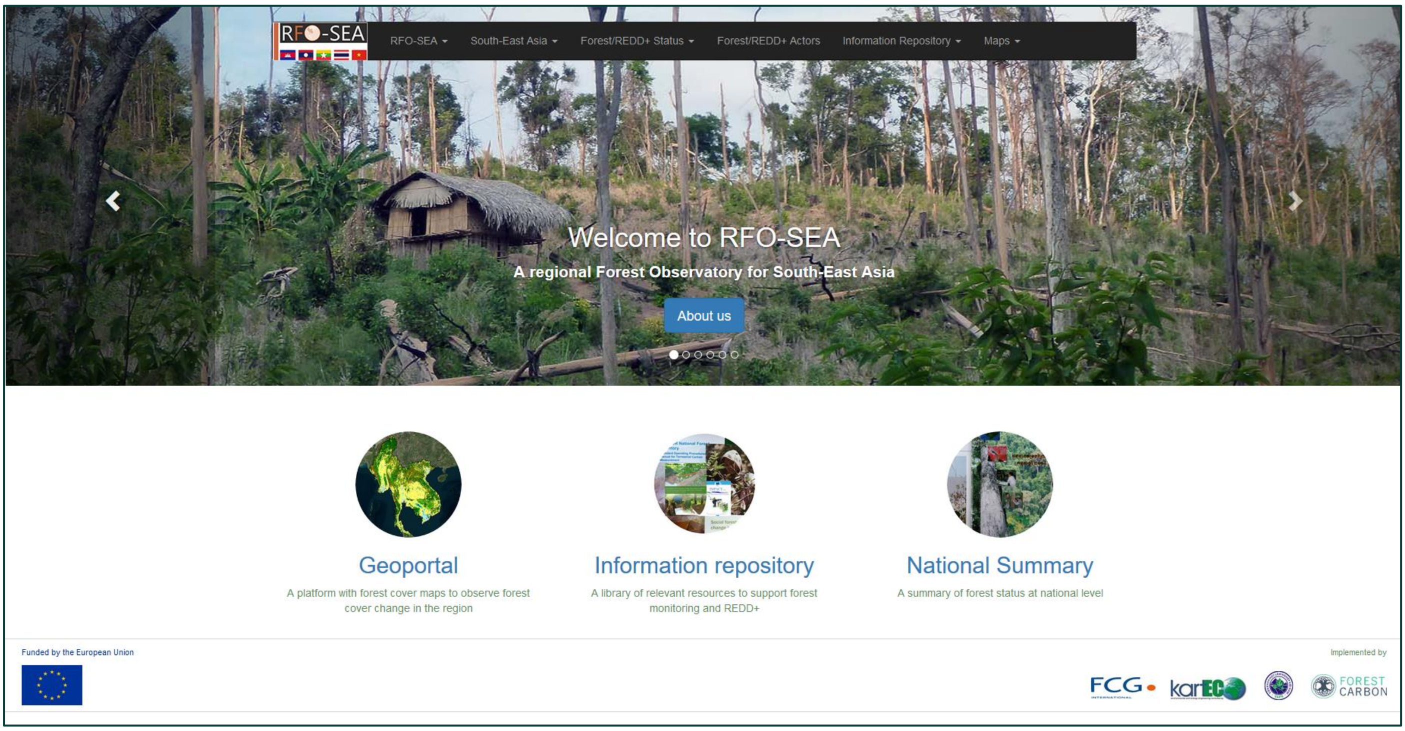

Fig. 8: RFO-SEA web site

The RFO-SEA is hosted on a cloud-server in Singapore and for the time being accessible until the end of 2019 (http://www.rfo-sea.org/index.htm).

4.4. The IMPACT Tool

The latest version of the JRC IMPACT Toolbox (Fig. 9) has been presented, followed by a full-day training session.

The IMPACT Toolbox has been developed in the context of the ReCaREDD project. IMPACT is based on open-source technology, it is freely available at no cost, easy to use and does neither require installation nor necessarily internet connection. The functionalities cover the most common needs of Remote Sensing data and GIS processing, with an emphasis on forest mapping, forest change monitoring and emission reporting.

IMPACT offers two modules for calculating carbon emissions, 'CarbEF' and 'ForestER', the workshop and training mainly focused on the latter. The 'ForestER' workflow (Fig 10) starts from existing pixel-based forest / non-forest maps of two different reference dates, calculates the area of forest change and also accounts for a potential map of 'forest degradation'. Based on the forest change statistics and linked to biomass values (to be specified or provided as spatial map) the module calculates related C-emissions within the target area.

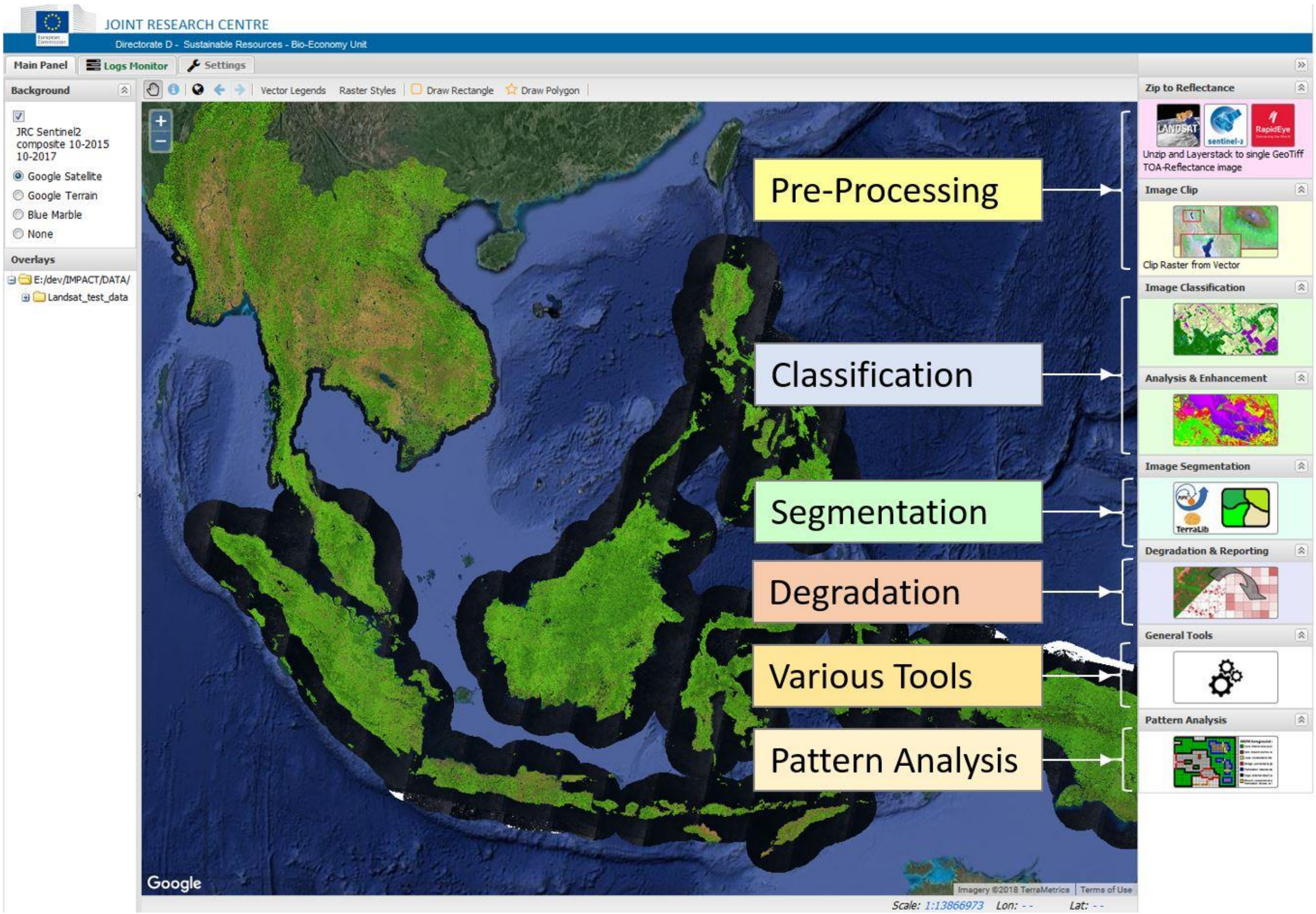

Fig 9: Main screen of IMPACT Toolbox

Access to IMPACT Toolbox: http://forobs.jrc.ec.europa.eu/products/software/impact.php

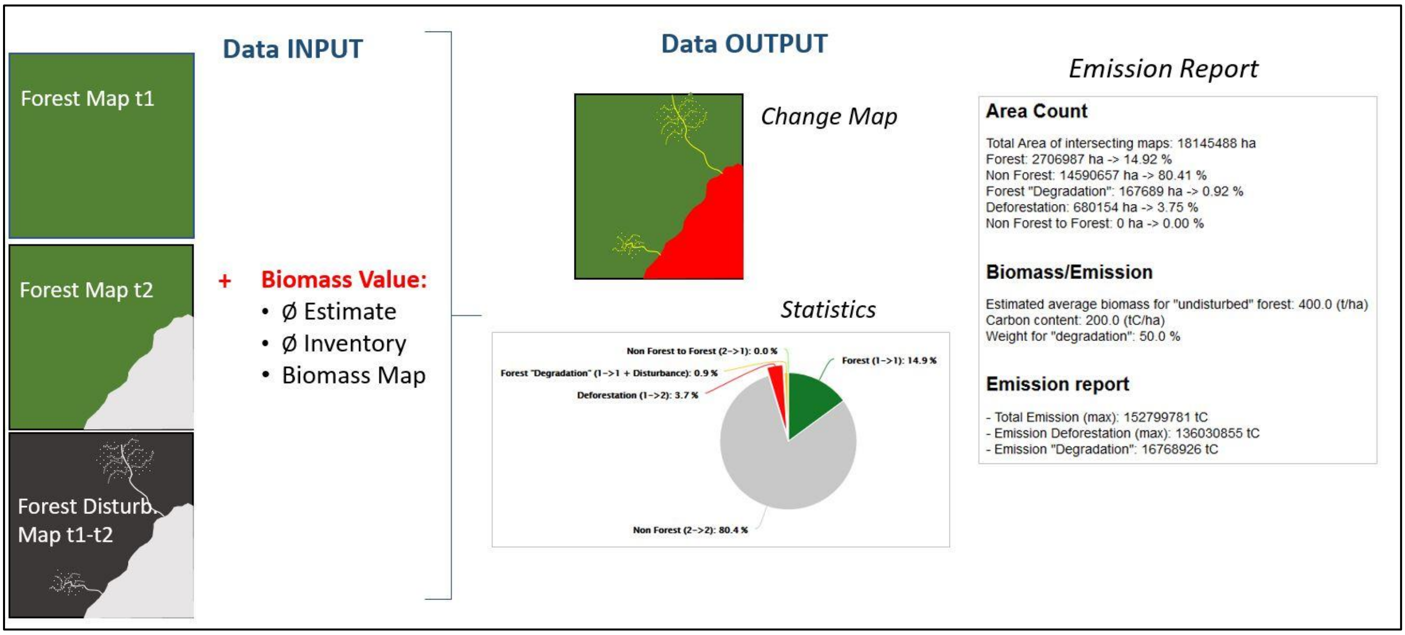

Fig 10: Workflow for emission reporting using the ForestER module

The present version of the ForestER interface for data input allows specifying different forest types (class codes of forest maps) and assigning for each class specific biomass values (Fig. 11). (more info available on wiki page)

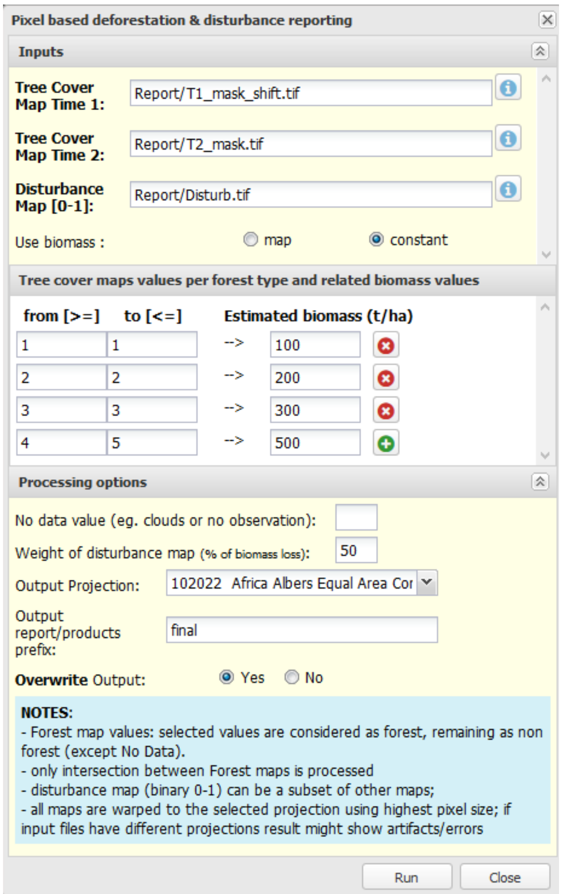

Fig 11: Data Input mask of the ForestER module

4.5. Provision and access to SENTINEL-2 (S2) satellite data

The workshop provided an update on the availability of and accessibility to SENTINEL-2 (S2) satellite imagery for the region of Southeast Asia. Since 2017, the Sentinel 2a and 2b satellites acquire imagery of 10m spatial resolution for any spot in the tropics at time intervals of 5 days, available at no cost.

S2 data is therefore seen as an ideal basis for country wide forest monitoring. However, the amount of data to be processed for a whole country is immense and most ReCaREDD partners face problems in downloading such large data amount due to instability or low capacity of the local internet.
The workshop demonstrated therefore access to S2 data through the JRC Sentinel2 web-portal (https://cidportal.jrc.ec.europa.eu/forobs/sentinel.py). The online platform was developed for REDD+ monitoring in collaboration with the JRC Big Data pilot project on Earth Observation and Social Sensing (EO&SS@BD)[4] for browsing and processing Sentinel-2 data over the tropics. The platform allows the user to perform pre-processing on the JRC server and to download products tailored to his needs (e.g. reduced bit-level, reduced number of bands, defined spatial resolution, data extraction for areas of interest (AoI) only), thus reducing significantly the amount of data to be downloaded.

For ReCaREDD partners, sets of best-quality S2 imagery of 2018 (6 bands: Blue, Green, Red, NIR, SWIR1, SWIR2) were processed at the JRC for full countries and were delivered to the national institutions, including additional country-wide 3-band image composites (Fig. 12 & 13). Furthermore, pan-tropical Sentinel-2 cloud free multi annual composites (2015-2017 and 2018) can be accessed through WMS and a dedicated web-based interface (http://forobs.jrc.ec.europa.eu/recaredd/S2_composite.php).

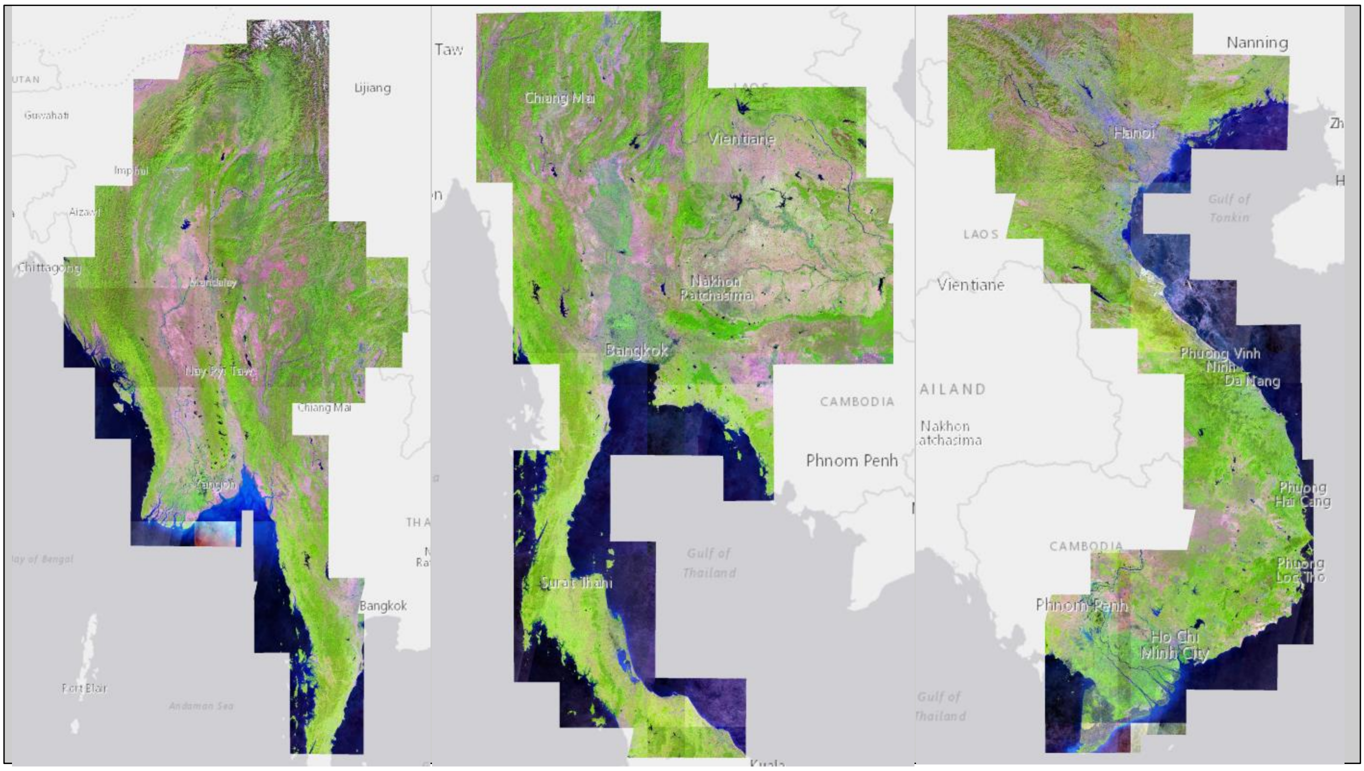

Fig. 12: S2 Image composites for 2018 for Myanmar, Thailand and Vietnam

[4] https://connected.cnect.cec.eu.int/groups/bigdataeoss)

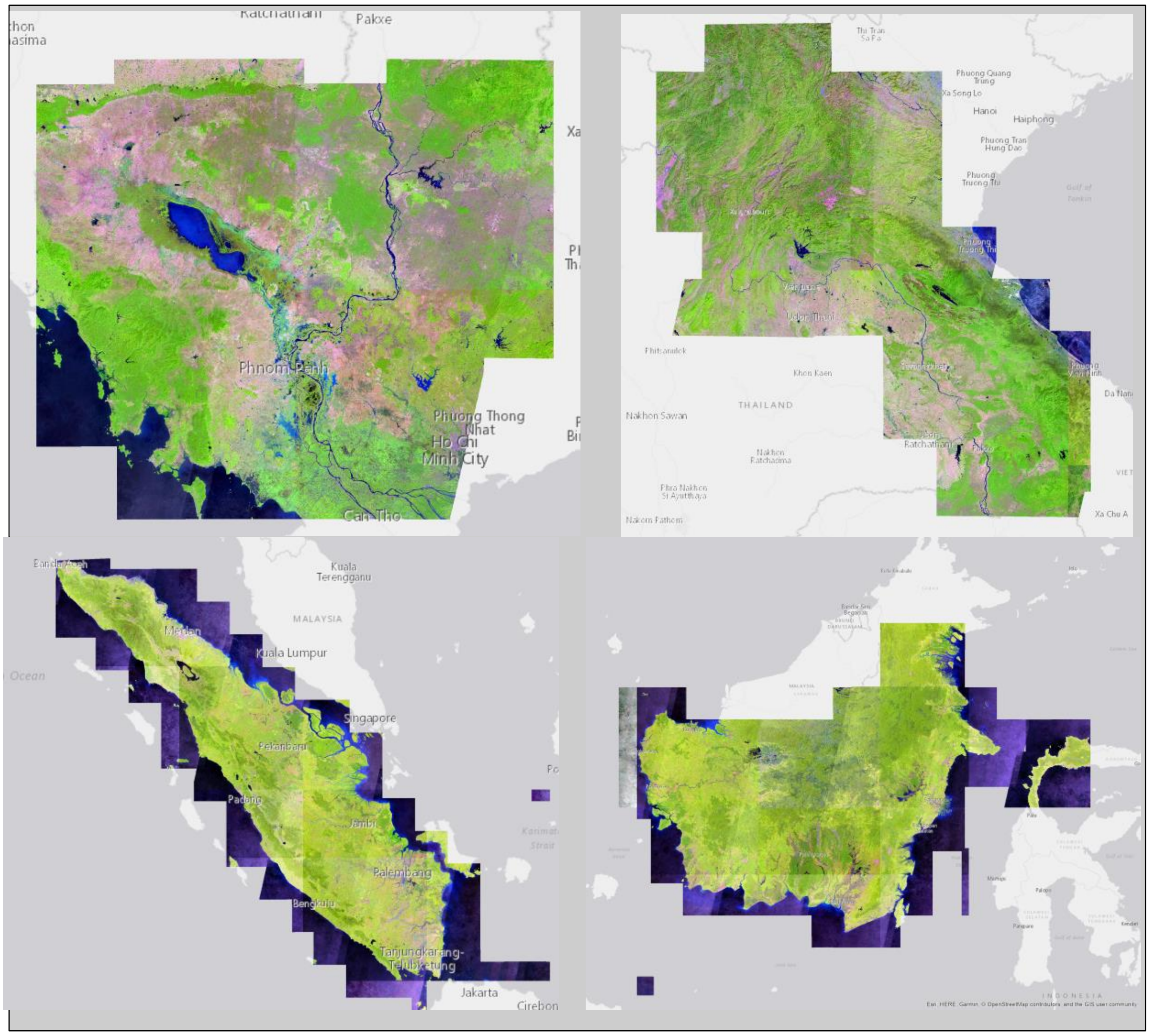

Figure 13: S2 Image composites for 2018 for Cambodia and Laos (top), and Sumatra and Kalimantan (bottom).

4.6. Presentations from organizations / projects

FAOP-RAP provided on overview on REDD+ activities in Asia and Pacific, informing about the status of submission of Reference Levels (FREL/FRL) and methodologies applied in SE-Asian countries, but addressing issues of 'definitions', 'uncertainty', 'NDCs' (National Determined Contributions) and 'RBPs' (Result based payments).

The V4MF (Voices for Mekong Forests) project presented a concept for empowering and networking Non-State-Actors in three trans-boundary landscapes to monitor and respond appropriately for strengthening forest governance, and to engage in forestry-related policy processes (particular FLEGT-VPA, REDD+). For the development of the project's forest governance information and monitoring system linking to the RFO-SEA database could be of interest.

The SERVIR Mekong project presented an approach of producing land cover data from Remote Sensing data using cloud computing (GEE) in a very flexible, user-oriented and transparent way. The approach is based on a modular system architecture, creating biophysical layers (map primitives) as input to an assembly algorithm for land cover map production. Links with the RFO-SEA would be of interest.

J. Himel (Aruna Technology) demonstrated the concept proposed for the ProFLEGT project (GIZ, Laos) of using ΔrNBR output as criteria for selecting PLANET satellite (3m resolution) data, which would be used for visual verification of logging activities in the context of the Lao national FLEGT program.

5. Feedback from Participants / Stakeholders[5]

5.1. Regional map of evergreen forest in SE-Asia

In general, there is interest in getting full access to the regional forest data set. Participants saw possibilities of using this map as additional reference, comparing to the national maps, or for spotting most recent forest changes not yet reflected in national maps. A drawback of the data set is seen in the fact, that deciduous forest cover is not represented on the map, which is an issue for the Mekong countries with significant amount of mixed and dry deciduous forest cover. Questions were also raised in terms of whether a continuous update of the data set (after ReCaREDD project) would be foreseen, providing to the countries also in the future annual 'updates'.

5.2. 'ΔrNBR canopy disturbance index' as basis for assessing potential forest degradation

There has been high interest in the approach for monitoring potential forest degradation, not only by participants but also by other stakeholders.

Across the region, there are different approaches for assessing and reporting 'forest degradation':
In Cambodia, Myanmar, Thailand 'forest degradation' is not (yet) assessed or reported. In Laos areas of regrowth after shifting cultivation are reported as 'degraded forest'. In Vietnam three quality classes of evergreen forests are mapped depending on standing stocks (high, medium and low volume). The transition from a higher to a lower volume class has been considered 'forest degradation' up to recently. Whilst biomass measurements stem from forest inventory, the spatially extension of these measurements to the forest maps and their mapping units (the majority not containing inventory plots) based on spectral appearance on satellite imagery remains 'challenging'. In Indonesia the mainly humid tropical evergreen forests are classified as 'primary' (no human impact) and 'secondary' forests (human impact). When signs of disturbance (human impact such as logging, mining) become visible on satellite imagery, the affected area is manually delineated and classified as secondary forest. The transition from primary to secondary forest is taken as 'forest degradation'.

Indonesia: Participants see potential to use the JRC ΔrNBR methodology for 'replacing' the visual/manual approach presently applied, expecting higher efficiency and consistency due to the rather automated procedure. A tailored workshop on the application of the JRC approach (ΔrNBR index) in Indonesia was considered useful. *Cambodia:* There is interest in further training on the ΔrNBR methodology for close-to-real-time monitoring of illegal logging activities. *Laos:* The *Pro-FLEGT project* (GIZ) in Laos intends to use the ΔrNBR tool for an Operational Logging and Degradation Monitoring (OLDM) System, targeting close-to-real-time monitoring under FLEGT. Staff from the Department of Forest Inspection (DOFI) expressed their interest in further training on using the ΔrNBR for monitoring logging at provincial level. The *F-REDD project* (JICA) applies stem counting though field-based sampling for degradation monitoring under the REDD+ scheme. JICA is testing to which extent the labour-intense fieldwork can be replaced by using the ΔrNBR for subsequent monitoring years.

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[5] *including feedback from post-workshop meetings in Sep 2018*

Vietnam: FIPI is using the ΔrNBR approach (and a modified version ΔrNDVI) in combination with other forest maps in order to derive indicators for degradation and re-greening at the level of mapping units. This could support the revision of the past five cycles of National Forest Inventories (NFIs) maps in terms of forest degradation, replacing the former approach of assigning polygons to low, medium and high forest quality classes. *Thailand / Myanmar*: Participants expressed interest in additional training and technical support from JRC on using the ΔrNBR as well as on the IMPACT Tool.
FAO: FAO-RAP indicated interest in having the methodology presented in the context of up-coming workshops in the region (e.g. Myanmar).

5.3. Regional Forest Observatory - Southeast Asia (RFO-SEA)

Based on the feedback from the final 'roadshow' J. Ferrand reported an increased interest of regional stakeholders in the RFO-SEA, compared to the feedback from the initial 'roadshow' of 2017. This is partly due to the fact, that now the RFO-SEA prototype is available and accessible, i.e. stakeholders can see the concept and contents through the web.
However, the interest of government forestry institutions appears to remain moderate. They still see limited benefit for their national tasks whilst they would have to cope with the workload of providing and updating available national datasets. They would therefore like to see / need more incentives for getting more actively involved in the RFO-SEA.

In general, it would be essential to identify a regional institution - with a mandate in the forestry / environment sector and accepted by national institutions - willing and interested in hosting the RFO-SEA in the long term. This could not yet be achieved by the project. FAO-RAP (Bangkok) indicated some interest in acting as future host for the RFO-SEA. FAO would discuss internally at RAP and send feedback to JRC. Also the EU-funded V4MF (*Voices for Mekong Forests*) project, located at RECOFTC (*The Center for People and Forests*, Bangkok), indicated possibility for hosting the RFO-SEA. Further discussion with V4MF will depend on the conclusions from the ReCaREDD steering committee. EUD staff proposed to also include the Mekong Institute (MI) at Bangkok (www.mekonginstitute.org) in the list of potential hosts for the RFO-SEA.

5.4. IMPACT Toolbox

There is general interest in using the IMPACT Toolbox.

Indonesian participants asked for an option for specifying more than just one input forest class (i.e. *forest* versus *non-forest*), where related biomass values could be defined. (This option has been implemented in the latest version.)

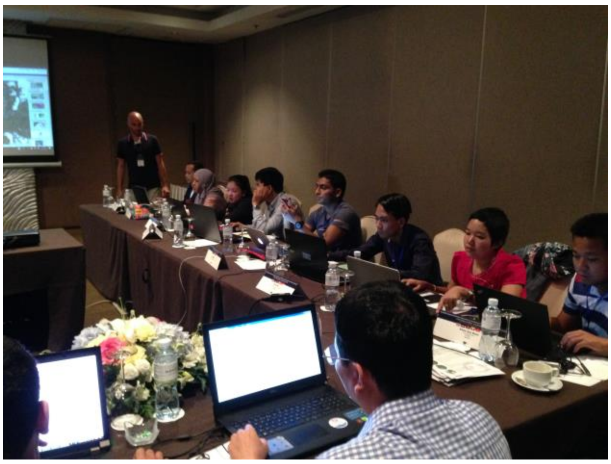
Participants from Myanmar and Thailand are interested in additional training on the use of the IMPACT tool, as they had no chance to participate in the national training sessions held in the ReCaREDD focus countries.

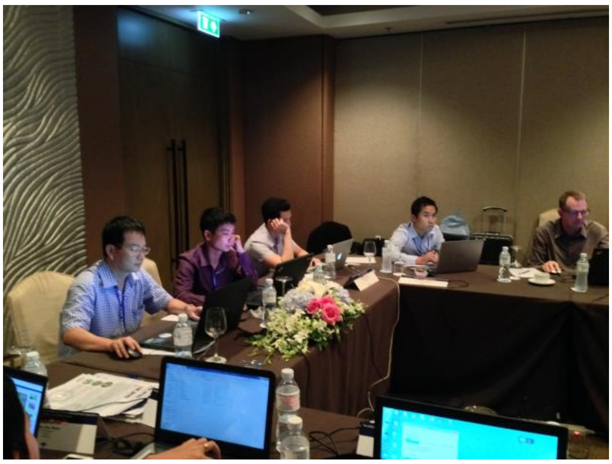
The Vietnamese counterpart FIPI is planning to use the IMPACT Toolbox in the context of the foreseen revision of forest maps of the last five cycles of National Forest Inventories (NFIs).

5.5. Provision and access to SENTINEL-2 (S2) satellite data

The provision of a country-wide coverage of S2 imagery for the year 2018 as well as of country wide 3-band 2018 S2 pixel composites (generated at JRC) was highly appreciated by ReCaREDD partners, who still face difficulties in downloading large amount of image data through the internet.

6. Workshop Photos





7. List of Participants

Name	Organization	Country
Ms Hout Naborey Mr Menh Khidorang	GDANCP (MoE)	CAMBODIA
Mr Pak Chealy	Forest Admin (MAFF)	
Mr Doni Sri Putra Ms Anna Tosiani	DG Forest Planning (MEF)	INDONESIA
Ms Belinda A Margono	DG Climate Change (MEF)	
Mr Soukanh Bounthabandid Mr Somxai Phaophongsavath	FIPD (Dep. of Forestry / MAF)	LAOS
Mr Sithong Thongmanivong Mr Vansalerm Phengvichit	NUoL (Nat. University)	
Mr Khine Zaw Wynn Mr Phyo Wai Ms Eai Chit Thu Mg	Forest Department (MoNREF)	MYANMAR
Mr Kraiwut Siri-on	RFD Royal Forest Department	THAILAND
Ms Suttatip Chormali	DNP Dep. Nature Prot. & Parks	
Ms Napaporn Kaomim	Kasetsart University	
Mr Nguyen Dinh Hung Mr Pham Ngoc Hai Mr Le Anh Hung	FIPI Forest Inventory & Planning Institute (MARD)	VIETNAM
Mr Jeremy Ferrand	Forest Carbon – RFO-SEA	REGIONAL / INTERNATIONAL ORGANIZATIONS AND PROJECTS
Mr Mathieu VanRijn	FAO - Reg. Office Asia-Pacific	
Mr Abu Mahmood	FAO - Reg. Office Asia-Pacific	
Mr Etienne Delattre	RECOFTC / V4MF Project	
Mr Ate Poortinga	SERVIR – Mekong (ADPC)	
Ms. Francesca Gilli Ms Sutthiya Chantawarangul	EU-Delegation Thailand	EU /JRC
Mr Andreas Langner Mr Dario Simonetti Mr Hans-Jürgen Stibig	EC-Joint Research Centre	
Mr Uday Pimple	Univ. of Technology Thonburi	OTHER
Mr Jeffrey Himel	Aruna Technology	

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