

Using the deforisk QGIS plugin for making and comparing deforestation risk maps



Ghislain VIEILLENDENT¹ Thomas ARSOUZE¹ FAO team²

[1] Cirad UMR AMAP, [2] FAO Rome and Latin America



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Outline

1 The deforisk QGIS plugin

- Aim and specificities
- Website and documentation
- Installation

2 Data preparation

- Get variables
- Forest cover change data
- Spatial explanatory variables

3 Models and validation

- Benchmark model
- Forestatrisk models
- Moving window models

4 Usage

- Allocating deforestation
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- User's data

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- Perspectives

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Aims

- Provide a **tool** to create and compare **deforestation risk maps**.
 - At the **jurisdictional** level.
 - Following **Verra's methodology** for certification.
 - **Allocating deforestation** to projects within the jurisdiction.

Specificities

- Open-source and Python based : transparency, reproducibility.
 - Computationally efficient :
 - Processing raster by blocks.
 - Running tasks in parallel.
 - OS independent : Windows, Linux, MacOS.
 - Should run on any computer with average performance.
 - Performant alternative statistical models (iCAR).
 - Fully documented and translated (English, Spanish, French).
 - Help with data preparation.
 - Should be (relatively) easy to use.

Python based

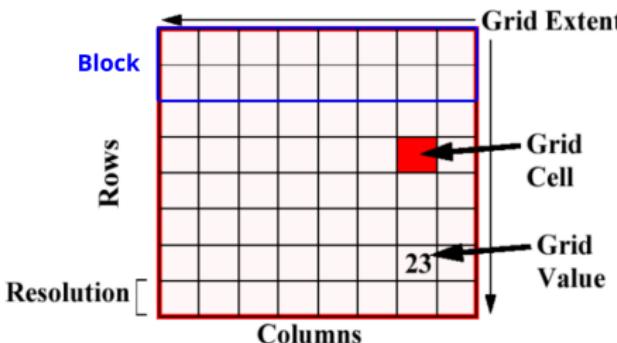
The deforisk plugin relies on four Python packages developed specifically for modelling deforestation :

- `geefcc` : make forest cover change maps from Google Earth Engine (GEE).
- `pywdpa` : downloading protected areas from the World Database on Protected Areas (WDPA).
- `forestatrisk` : model deforestation and predict the spatial deforestation.
- `riskmapjnr` : risk maps following Verra JNR methodologies.



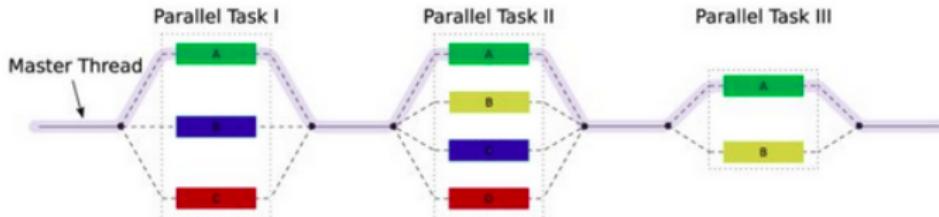
Processing raster by blocks

- Raster files of forest cover change and explanatory variables might occupy a space of several gigabytes on disk.
- Processing such large rasters in memory can be prohibitively intensive on computers with limited RAM.
- Functions used in the deforisk plugin process large rasters by blocks of pixels representing subsets of the raster data.
- This makes computation efficient, with low memory usage.



Running tasks in parallel

- State-of-the-art approach to select the best risk map implies repeating tasks (model, periods).
- To save computation time, the deforisk plugin use the QGIS task manager.
- Allows running several analysis in parallel.

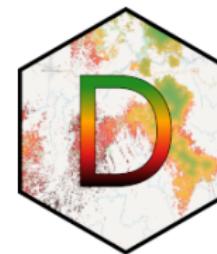


Website and documentation

The website includes all the documentation to use the plugin :

- **Installation page** : How to install the plugin ?
- **Plugin API page** : What is the meaning of each parameter ?
- **Get started page**. How to start using the plugin on a small area of interest ?
- **Articles' page**. How can I use the plugin for specific cases (subnational jurisdictions, user's data) ?
- **References' page** : A page with reference documents including presentations.

<https://deforisk-qgis-plugin.org>



Installation

Reduced number of steps for installing the plugin :

- Install QGIS and GDAL on you system (using OSGeo4W on Windows).
- Install the `forestatrisk` and `riskmapjnr` Python packages using pip.
- **Download** and install the `deforisk` plugin from QGIS.
- (Unix-like systems only : install OSM tools).

The screenshot shows a web-based documentation page for the 'deforisk QGIS plugin'. The header includes the logo, navigation links (Home, Installation, Get started, Articles, Plugin API, More), and a search bar. The main content area is titled 'Installation' and contains a 'Note' box. The note states that QGIS and GDAL must be installed before using the plugin. It also mentions that on Unix-like systems, users must install osmconvert and osmfilter, which are included in the plugin as binary .exe files. The note further states that Python packages for 'forestatrisk' and 'riskmapjnr' must be installed. To the right of the note, there is a sidebar with links for 'On this page', 'On Windows', 'On Unix-like systems (Linux and macOS)', 'Access to GEE and WOPA', and 'Installing the deforisk plugin in QGIS'.

deforisk QGIS plugin

Home Installation Get started Articles Plugin API More

Search Ctrl + K

Installation

Note

Dependencies: QGIS and GDAL must be installed on your system before using the deforisk plugin. On Unix-like systems, you must also install osmconvert and osmfilter. On Windows systems, these dependencies are already included in the plugin as binary .exe files so you don't need to install them. Then, the forestatrisk and riskmapjnr Python packages must be installed on your system. Follow the instructions below to install these dependencies.

On this page

On Windows

On Unix-like systems (Linux and macOS)

Access to GEE and WOPA

Installing the deforisk plugin in QGIS

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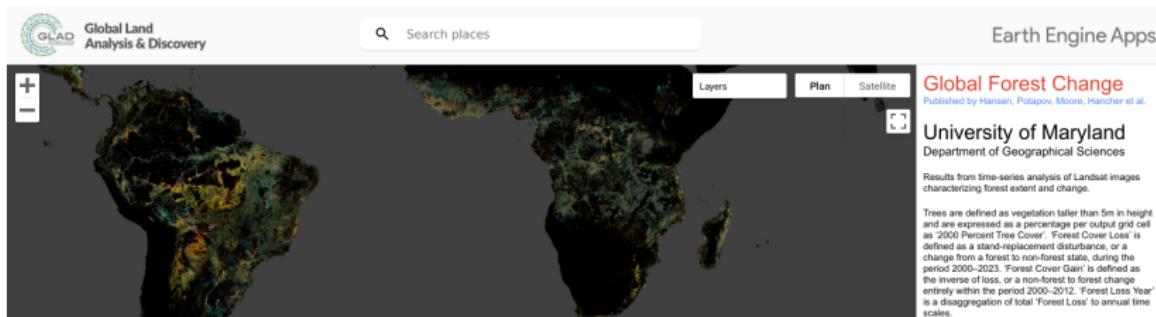
Get variables

- Functions to help prepare the data for modelling deforestation.
- Two different sources for **forest cover change** (GFC or TMF).
- Spatial explanatory variables describing **forest accessibility** and **land tenure** (altitude, slope, distance to roads, protected areas, etc.).



GFC dataset

- Hansen et al. 2013.
- Global dataset encompassing all forest types.
- Tree cover and annual tree cover loss.
- 30m resolution, from 2000 on.
- Data : <https://glad.earthengine.app/view/global-forest-change>



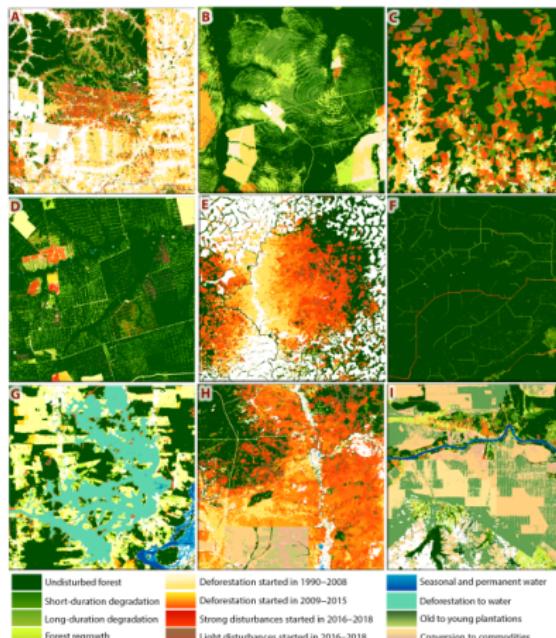
TMF dataset

- Vancutsem et al. 2021. Tropical Moist Forests (evergreen forest, no dry deciduous forests).
- 30m resolution, from 1990 on.
- Tropical deforestation was underestimated (-33% in 2000–2012, Hansen et al. 2013), especially in Africa.
- Data : <https://forobs.jrc.ec.europa.eu/TMF/>.



TMF dataset

- Precise enough to visually identify the causes of deforestation (logging, fires, agriculture)

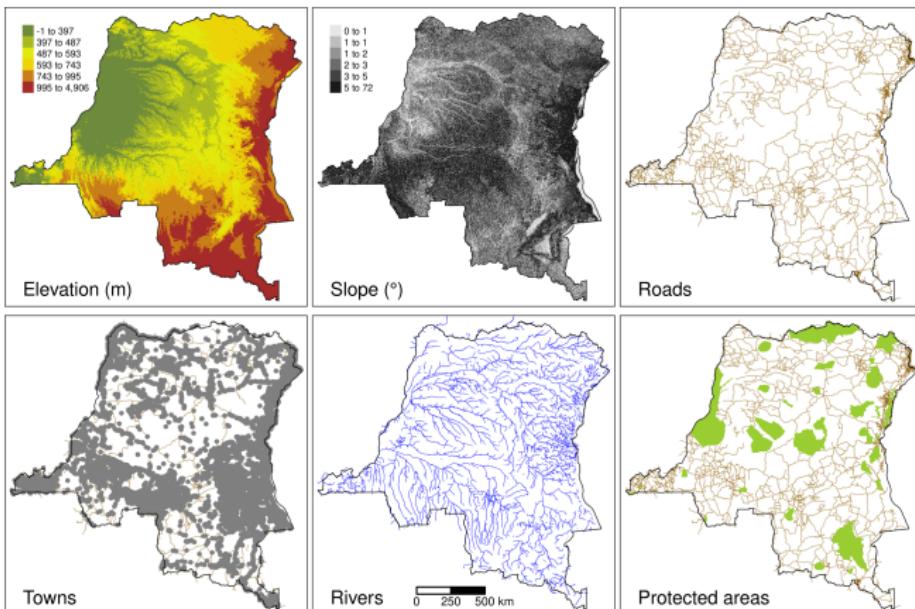


Spatial variables

The plugin helps computing height explanatory variables.

Product	Source	Variable derived	Unit	Resolution (m)	Date
Forest maps (2000-2010- 2020)	Vancutsem et al. 2021	distance to forest edge	m	30	—
		distance to past deforestation	m	30	—
Digital Elevation Model	SRTM v4.1 CSI-CGIAR	elevation	m	90	—
Highways	OSM- Geofabrik	slope	degree	90	—
Places		distance to road	m	150	March 2021
Waterways	WDPA	distance to town	m	150	March 2021
Protected areas		distance to river	m	150	March 2021
		presence of protected area	—	30	March 2021

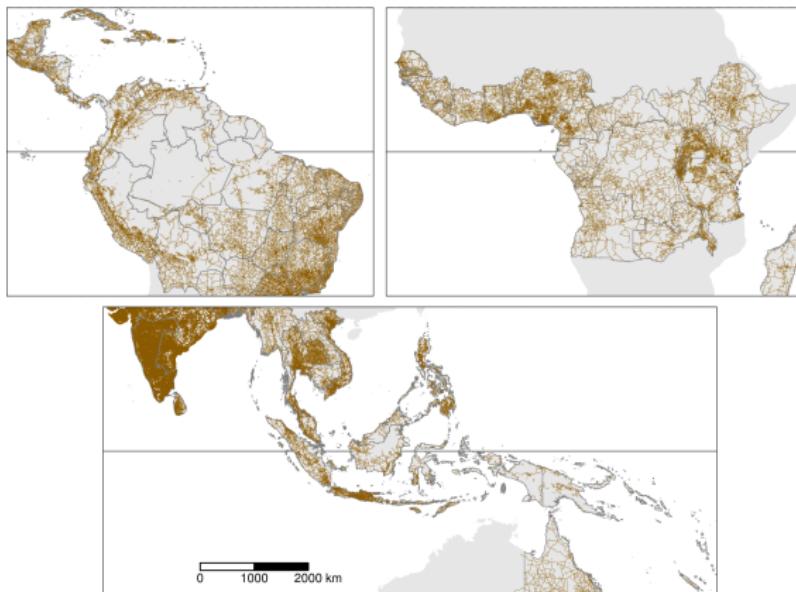
Spatial variables



Spatial explanatory variables in DRC

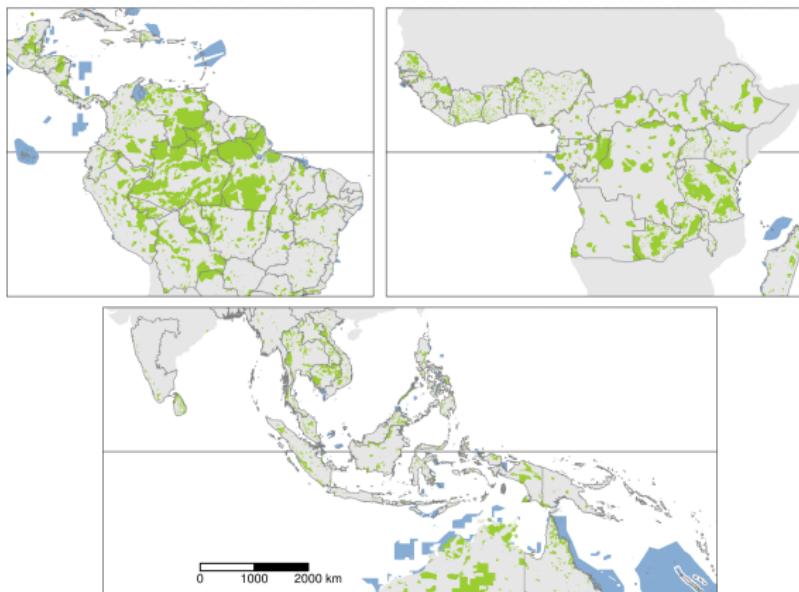
Roads

- OpenStreetMap (OSM)
- “motorway”, “trunk”, “primary”, “secondary” and “tertiary” roads
- 3.6 million roads from OSM



Protected areas

- PA status : “Designated”, “Inscribed”, “Established”, or “Proposed”.
- 85,000 protected areas from WDPA.



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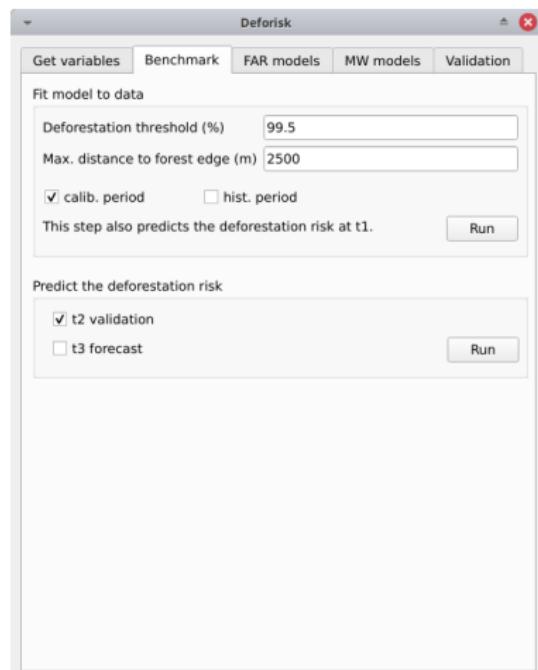
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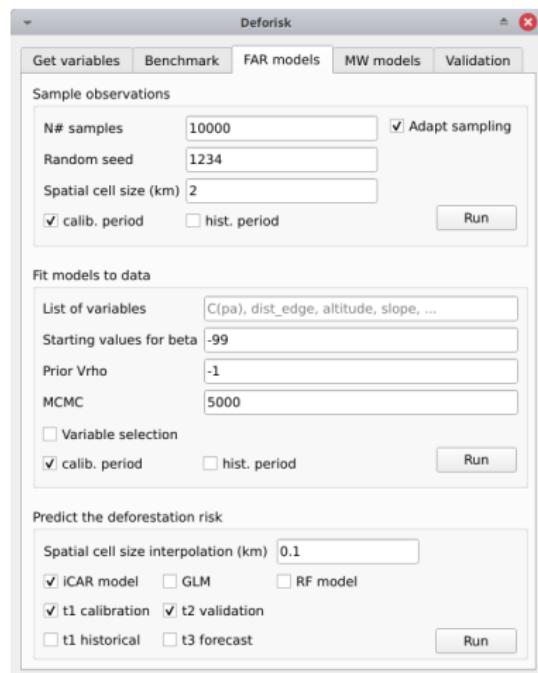
Benchmark model

- Benchmark model or reference model.
 - A reasonably good deforestation model (better than a null model).
 - Assuming a *decrease of deforestation with distance to forest edge* (commonly admitted).
 - And a *different model between subjurisdictions* (regional variability).
 - See presentation **Cirad and FAO**. 2024. **Jurisdictional risk maps for allocating deforestation**



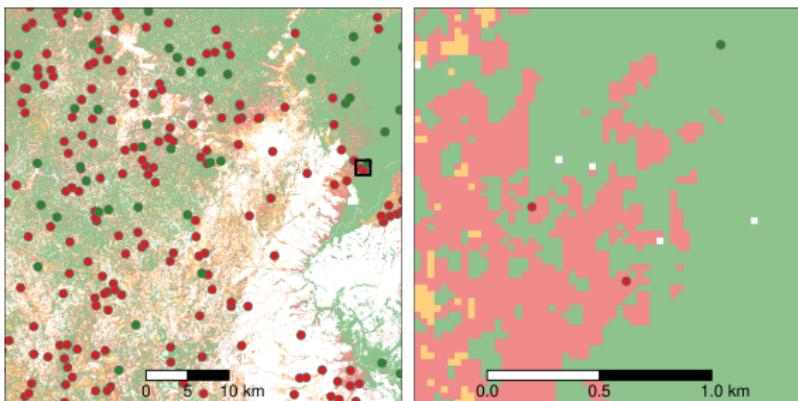
Forestatrisk models

- Three statistical models : iCAR, GLM, RF.
- iCAR : Logistic regression with spatial random effects (iCAR process).
- GLM : Generalized Linear Model, simple logistic regression (no random effects).
- Random Forest model : random regression trees.
- Statistical models based on a sample of the observations.



Sampling for FAR models

- We consider the forest cover change between t and $t + 1$.
- Stratified sampling between deforested/non-deforested pixels.
- Total number of points proportional to the forest cover (from 20,000 to 100,000 points per study area).



iCAR model

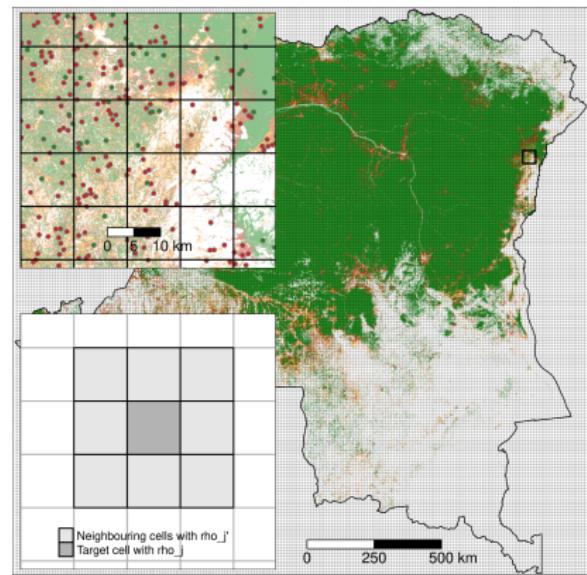
A logistic regression model with iCAR process :

$$y_i \sim \text{Bernoulli}(\theta_i)$$

$$\text{logit}(\theta_i) = \alpha + X_i\beta + \rho_{j(i)}$$

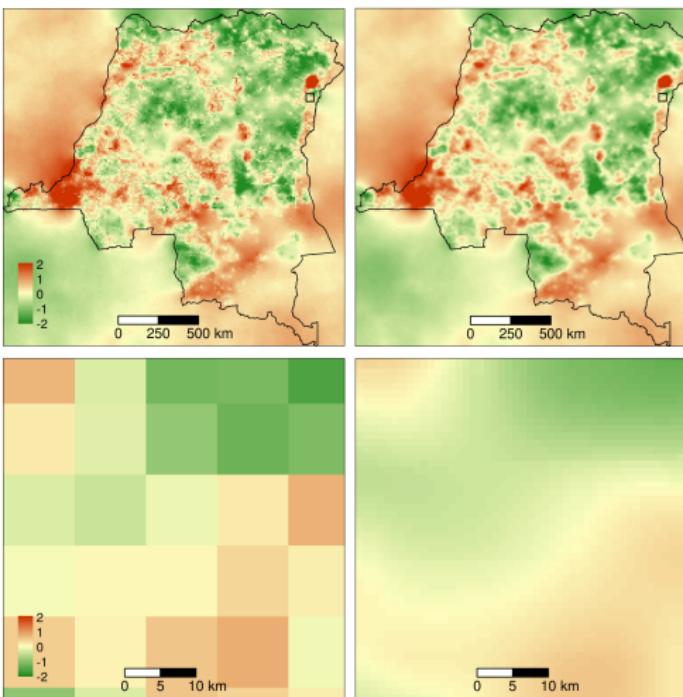
$$\rho_{j(i)} \sim \mathcal{N}ormal\left(\sum_{j'} \rho_{j'}/n_j, V_\rho/n_j\right)$$

Random effects $\rho_{j(i)}$ allows accounting for residual spatial variation not taken into account by model variables X_i .



Square grid of 10km cells over DRC

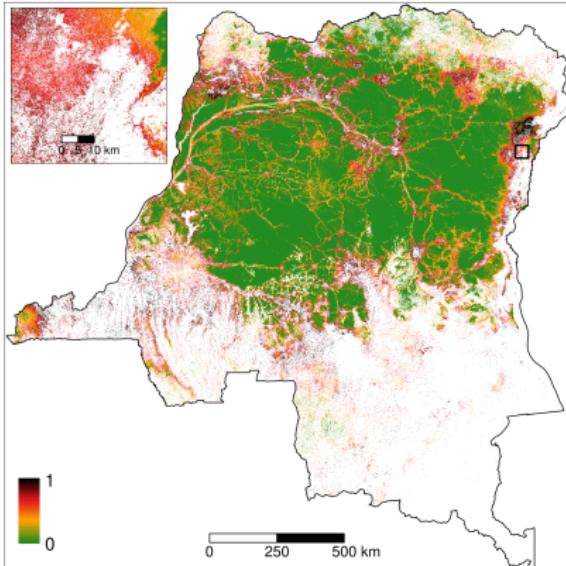
Spatial random effects



Interpolation of spatial random effects at 1km in DRC

Spatial probability of deforestation

- We use the fitted model to compute the spatial probability of deforestation.
- Probabilities in $[0, 1]$ are transformed into classes in $[1, 65535]$.



Relative spatial probability of deforestation in DRC

GLM model

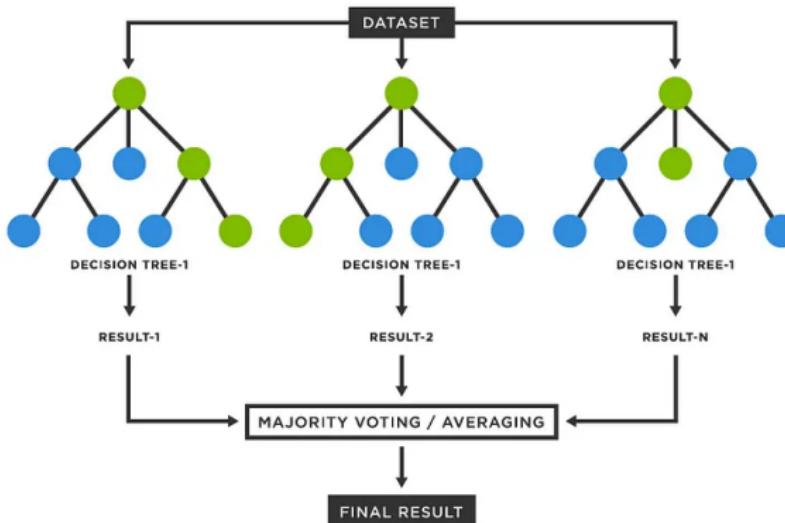
A simple logistic regression model without random effects :

$$\begin{aligned}y_i &\sim \text{Bernoulli}(\theta_i) \\ \text{logit}(\theta_i) &= \alpha + X_i\beta\end{aligned}$$

Easy to compare with iCAR to see the impact of spatial random effects.

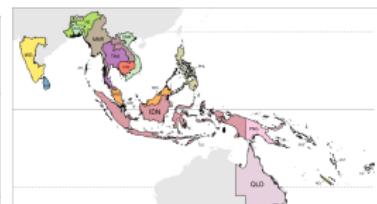
Random Forest model

- Random Forest is an ensemble machine learning algorithm.
- Combines multiple decision trees to create a more robust and accurate predictive model.



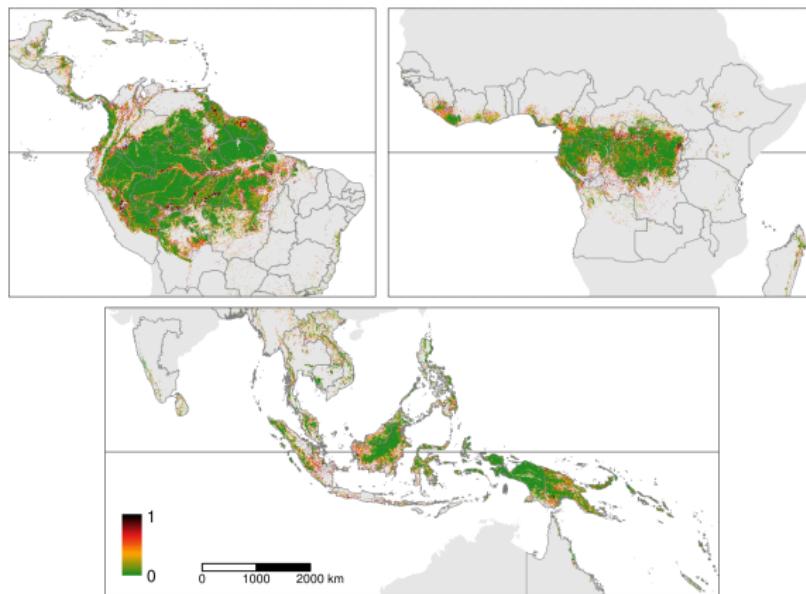
ForestAtRisk in the tropics

- i. Consider tropical moist forest in **92** countries (119 study areas)
- ii. Estimate the current deforestation rate and uncertainty in each country
- iii. Model the spatial risk of deforestation from environmental factors
- iv. Forecast the deforestation assuming a business-as-usual scenario
- v. Consequences in terms of carbon emissions



The 119 study areas in the 3 continents

ForestAtRisk in the tropics



Pantropical map of the spatial probability of deforestation
Article in review : [10.1101/2022.03.22.485306](https://doi.org/10.1101/2022.03.22.485306)
<https://forestatrisk.cirad.fr/maps.html>

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Allocating deforestation

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Perspectives

- Increase computational speed (for predictions on large areas).
- Adding more alternative models (MLP).



... Thank you for attention ...

<https://deforisk-qgis-plugin.org>

> Articles > References > Presentations



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