Methods and results for the environmental monitoring of an agro-ecological project

Presentation from the FORAE Project

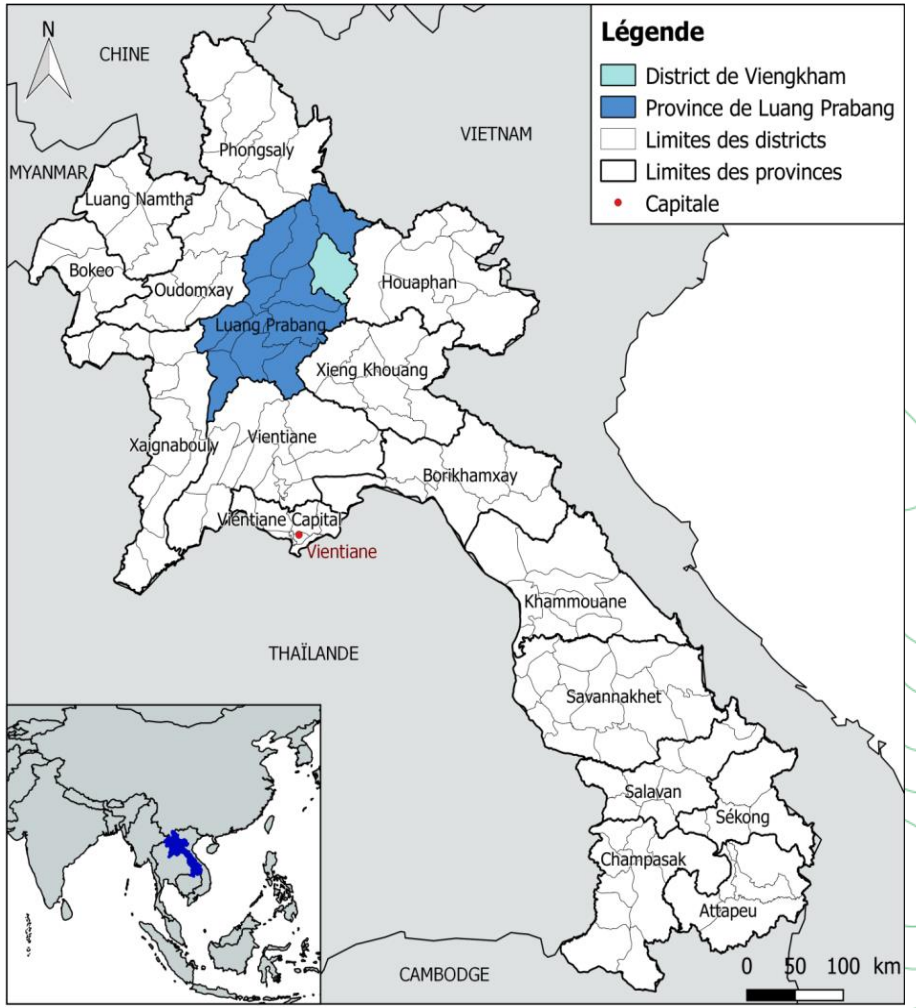
Marie Nourtier – 24-07-18

Program of the training

date		time	topic	speaker	tool required
Tuesday	24-juil	09:00	Welcome of the participants		
		09:30	Presentation of the FORAE project	Claire Kieffer	
		10:00 - 12:00	Presentation of the system of environmental monitoring of FORAE project (monitoring of land use, forest inventories, erosion, water flows, soil fertility, ...)	Marie Nourtier	
		14:00 - 14:30	Future projection of GHG: Presentation of the context and of the tool Ex-Act	Marie Nourtier	
		14:30 - 17:00	Future projection of GHG: exercise with Ex-Act based on a imaginary land use plan	Marie Nourtier	Use of Excel
Wed.	25-juil	09:00 - 09:45	Dynamic of historical deforestation : presentation of the issue of deforestation	Marie Nourtier	
		10:00 - 12:30	Rapid evaluation of historical deforestation within a project zone : exercise of how to manipulate data from the global tool GlobalForestWatch (raster data)	Marie Nourtier	GIS (QGIS v2.18)
		14:00 - 16:30	exercise with QGIS on how to map the land use of a projet area	Marie Nourtier	GIS (QGIS v2.18)
		16:30 - 17:00	Presentation on how to publish maps of the project on a web portal	Marie Nourtier	
Thursday	26-juil	8:00 - 9:00	Presentation of the theory of forest inventory	Marie Nourtier	
		10:00-14:00	Forest inventory on the field (how to measure trees on a plot to assess biomass and biodiversity)	Marie Nourtier	
		15:00 - 17:00	exercise on how to calculate biomass of a forest strata	Marie Nourtier	Use of Excel
		17:00	Closing cocktail		

FORAE project – agro-ecology

- Activities :
  - Technical support to producers – trainings on technical issues
  - Development of land use management plans – village scale
  - Environmental monitoring of the project
  - Capitalization on the project



Components of an environmental monitoring system – FORAE project

- Reference states :
  - Land use land cover map
  - Erosion risk
  - Forest biodiversity and biomass
  - Soil fertility – spatial variability
- Past and future changes analysis
  - Past deforestation
  - Land use changes between several dates
  - Future GHG emissions/sequestration
- Continuous monitoring
  - Water flows at sources and climate (rainfall, temperature)

Impact of the project on the component

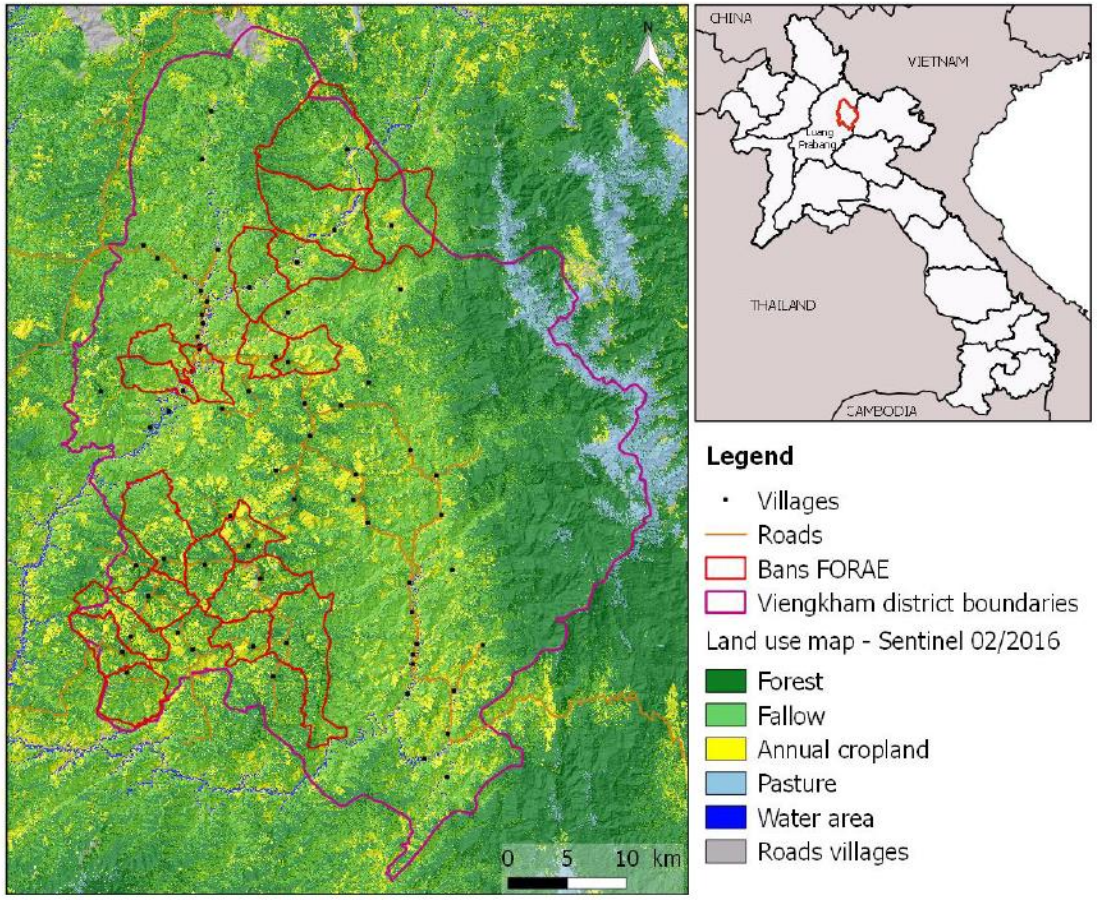
Control of the respect of law/engagement

Planification of activities

Monitoring for adaptation to climate changes

Land Use Land Cover (LULC) map

How would you use it?



Projection : WGS 84 - UTM 48 N
Resolution : 10 m
Dataset source : Sentinel 2 images aquired in february 2016.
Production : Etc Terra - Rongead/FORAE, december 2017

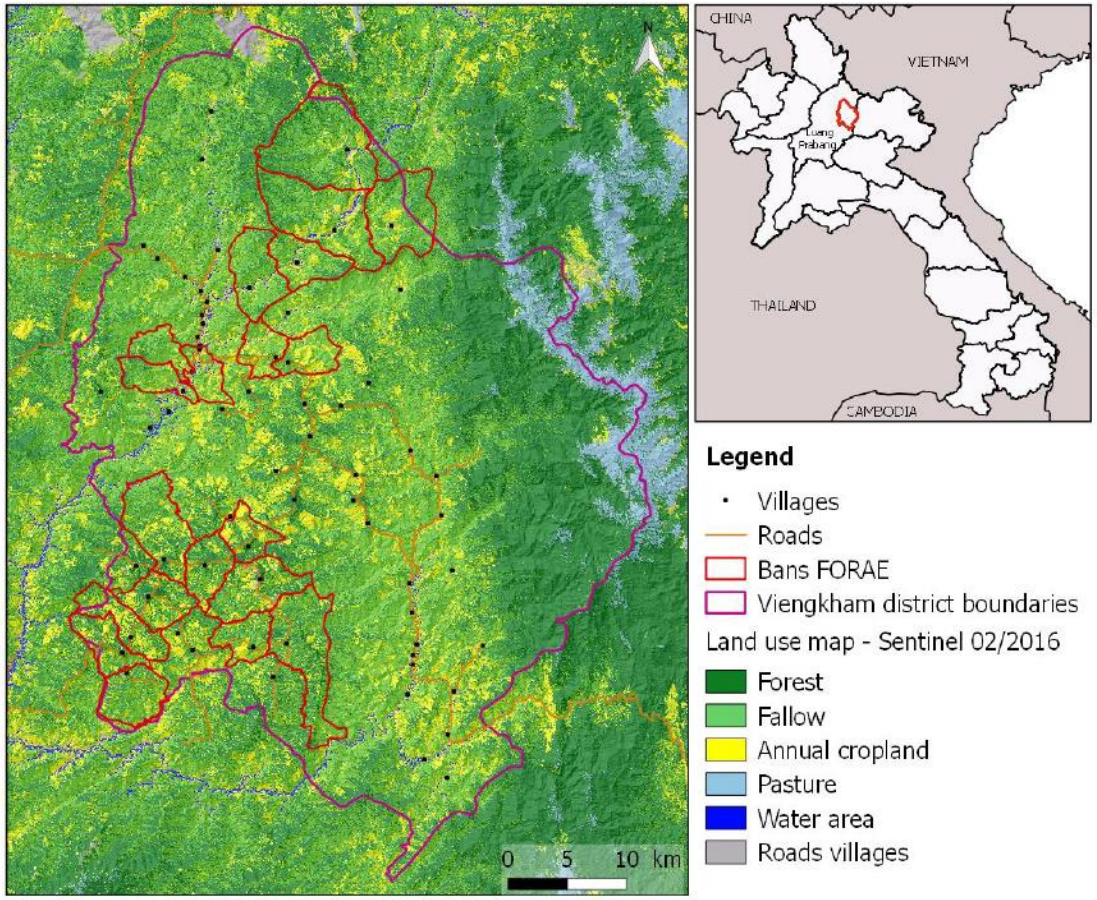
Land Use Land Cover (LULC) map

Interests:

- Knowledge of the landscape
- Tool to plan land management
- Tool to control the respect of land use rights and protection status

Method – **free softwares and images** :

- Supervised classification of Sentinel2 images
- Tools: QGIS and R



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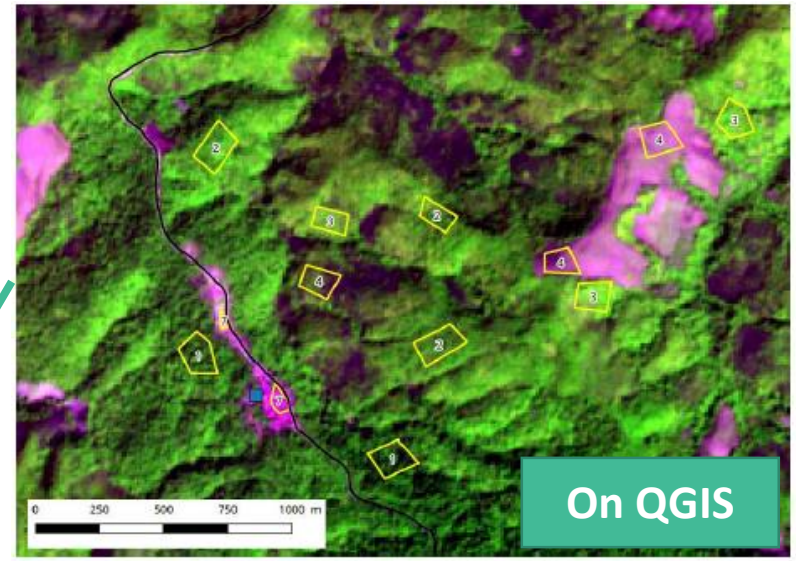

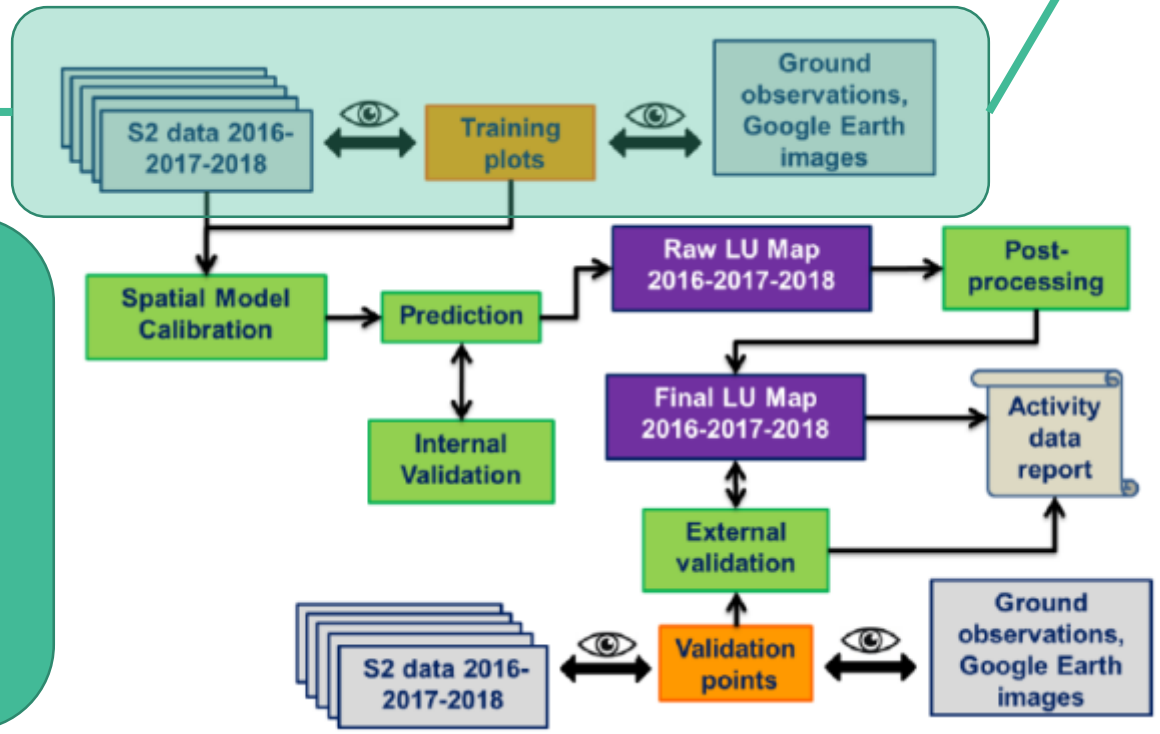

Freely available images suitable for LULC (optic + medium resolution) :

- Landsat images – 30m resolution – from 1973
- Sentinel 2 – 10m resolution – from 2015

7 classes detectable

Code	Short name
1	Forest
2	Fallow
4	Cropland
5	Pasture
6	Water
7	Roads

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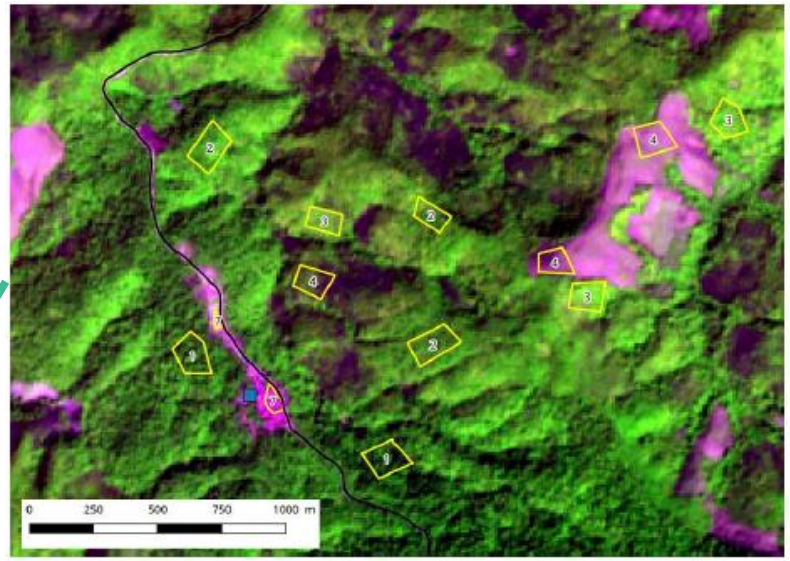
Land Use Land Cover (LULC) map



Method – **free softwares and images** :

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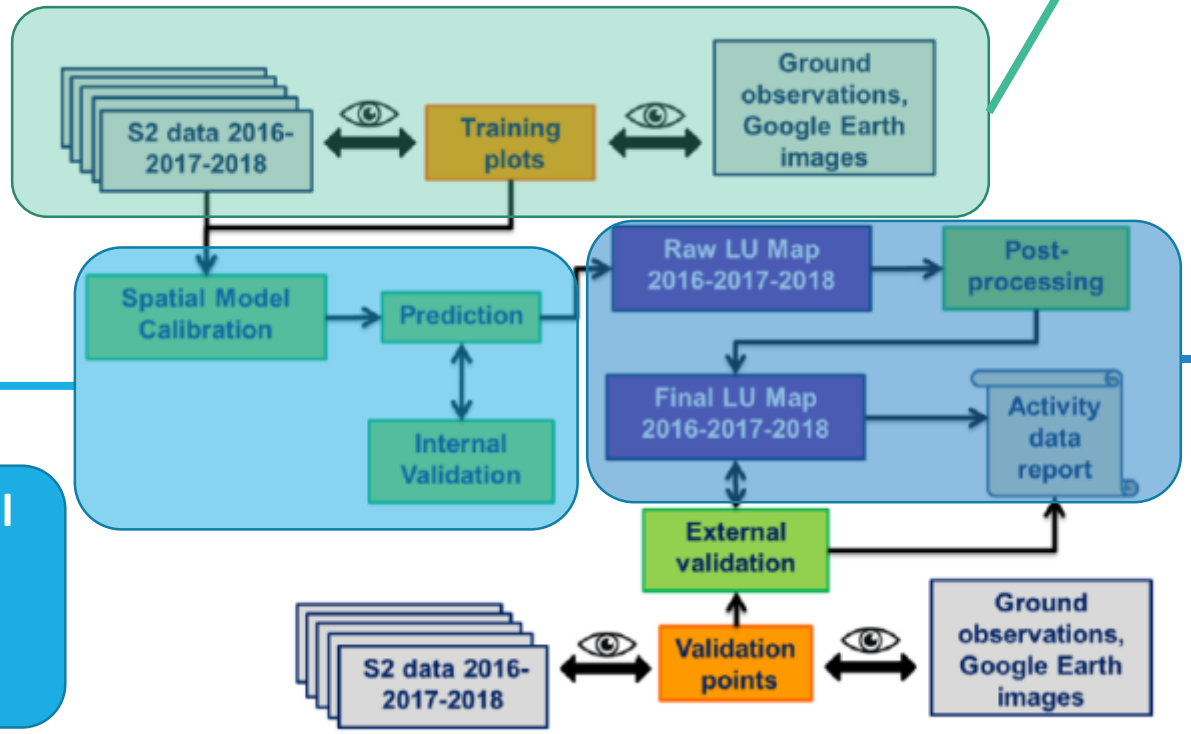


R script – use of the model RandomForest (decision tree for learning the classification rules)

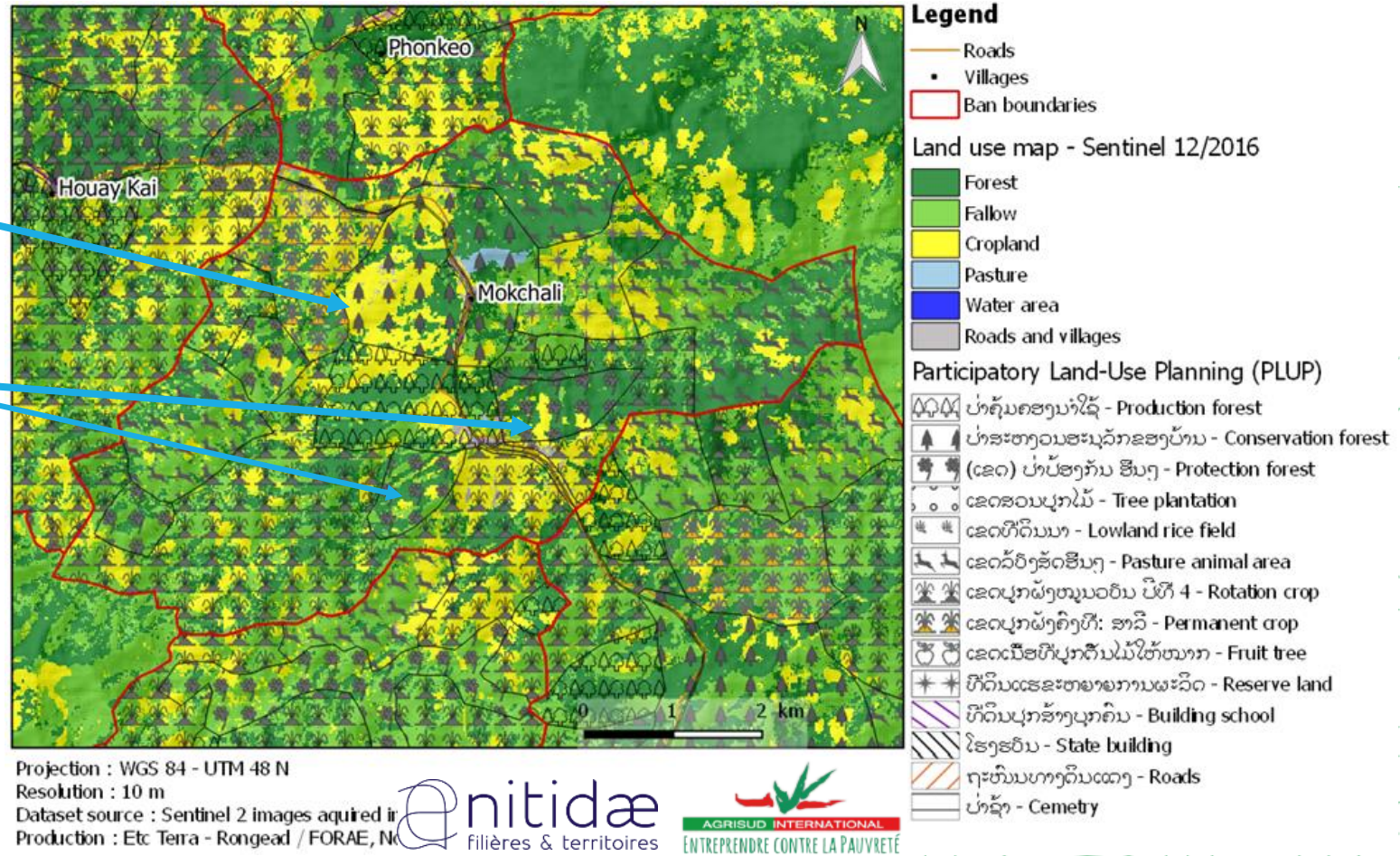
Use of the GRASS tools on QGIS software

Land Use Land Cover (LULC) map

Example of the use of the map by the project manager *(ASI for FORAE)* :

Crop land in classified conservation forest

Crop land in classified protection forest



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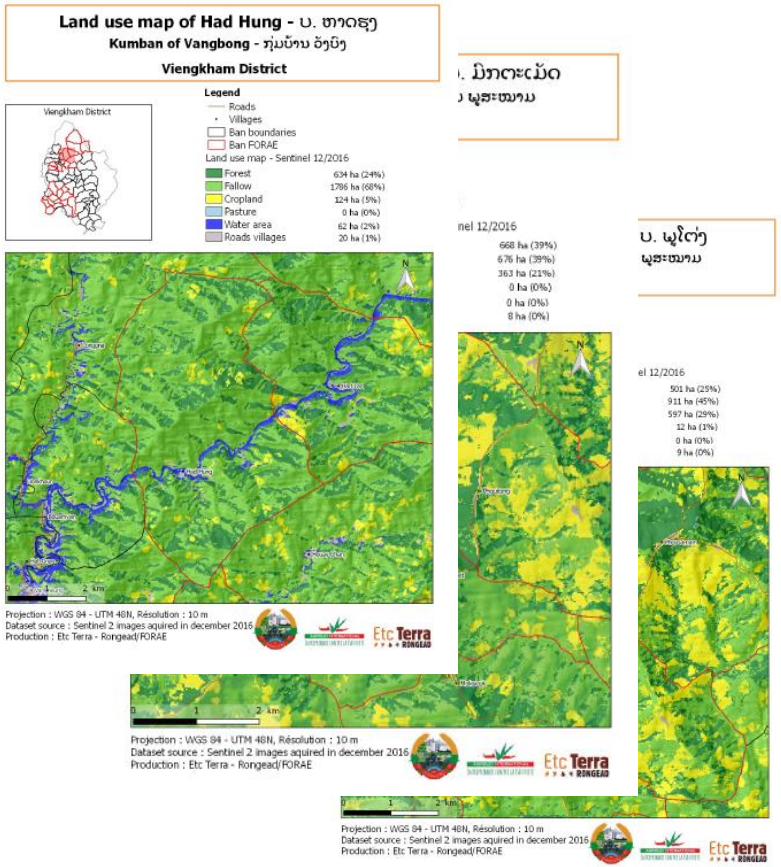
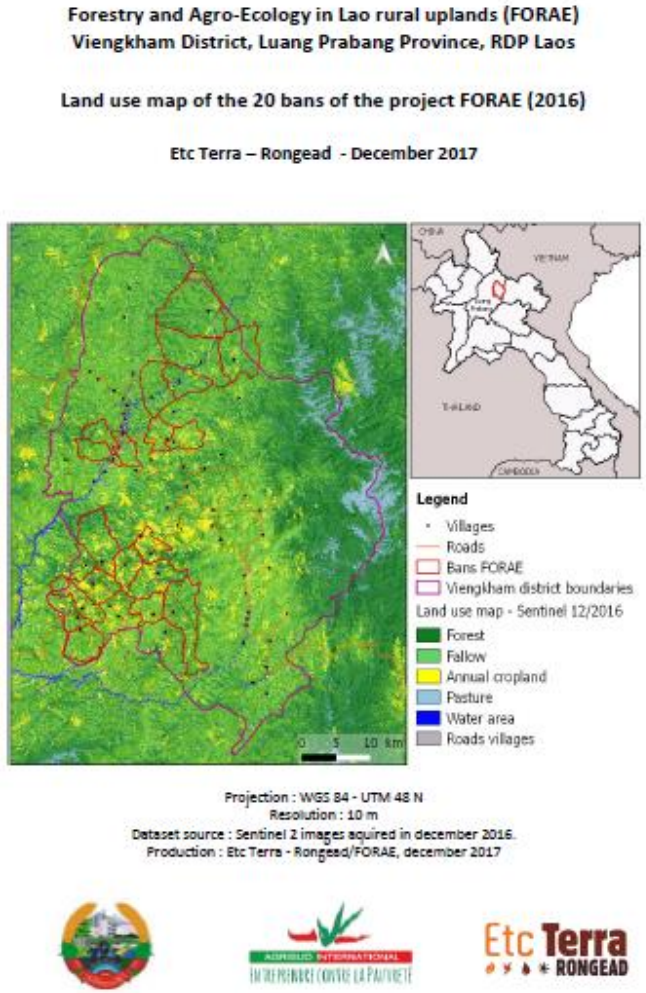
Production : Etc Terra - Rongead / FORAE, N

Here is an example of comparison in Mokchali between the satellite map in December 2016 and the PLUP map in December 2015.

Land Use Land Cover (LULC) map

Example: Creation of an Atlas





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Land Use Land Cover & Changes (LULCC) map

A map that shows evolution of land use land cover evolution in time:

- Comparison of 2 LULC maps
- Focus on specific themes:
  - deforestation
  - land degradation or regeneration
  - Changes on water bodies (lake)
  - Etc.

How would you use it?

Land Use Land Cover & Changes (LULCC) map

A map that shows evolution of land use land cover evolution in time:

- Comparison of 2 LULC maps
- Focus on specific themes:
  - deforestation
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  - Changes on water bodies (lake)
  - Etc.

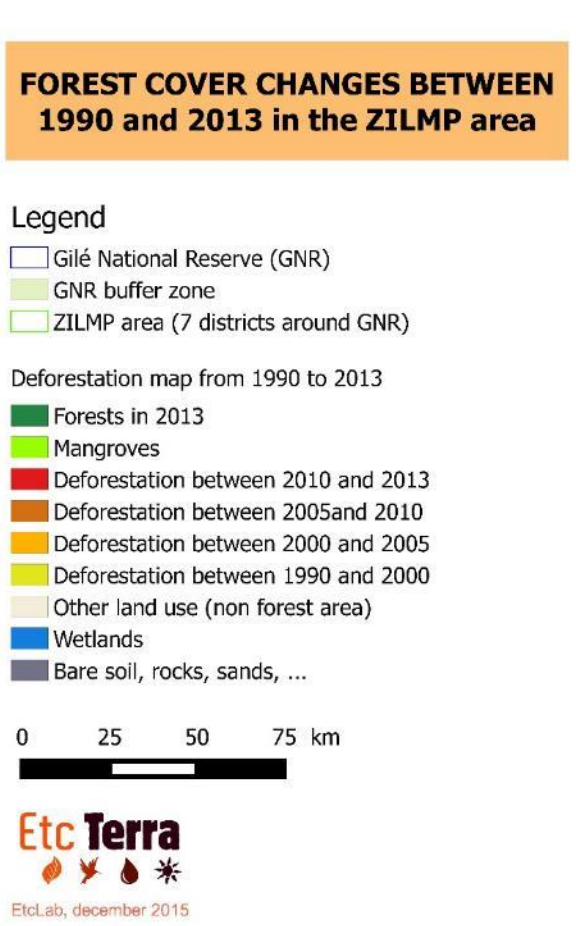
Method:

- 2 supervised classifications of LULC and difference
  - ➔ increase of errors
- Direct detection of changes (supervised classification including changes):
  - ➔ reduction of errors
  - Limited number of changes/classes that can be detected

Land Use Land Cover & Changes (LULCC) map

Example of deforestation map
(RNG project – Mozambique – nitidæ):

- Use to determine relevant locations for activities
- Monitoring of the impact of the project
- Calculation of GHG emissions and projection in the future

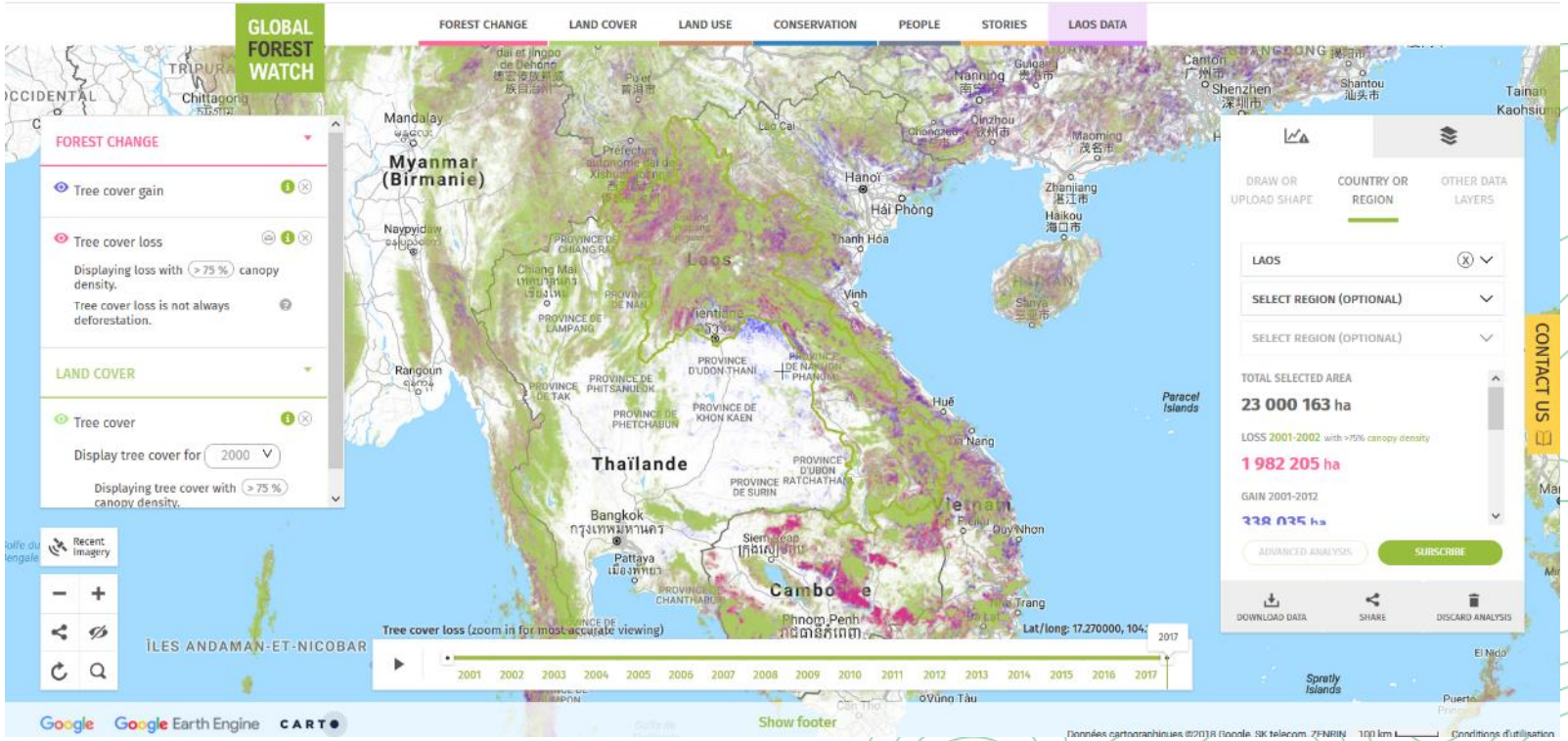


Land Use Land Cover & Changes (LULCC) map

Example of free global tools:

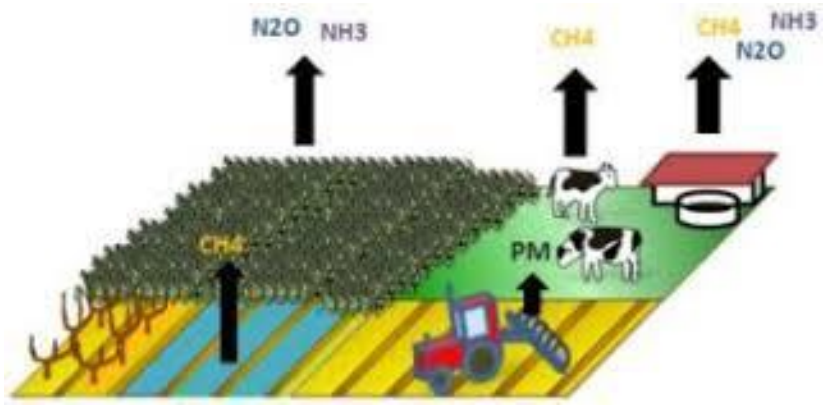
- For deforestation: https://www.globalforestwatch.org/
  - For rapid assessement
  - Data without local validation

Training on the use of those data the 25/07/2018



Curent and future GHG emissions

- Objective: calculate the emissions related to land use on your territory



How would you use it?

Curent and future GHG emissions

- Objective: calculate the emissions related to land use on your territory
  - Orientation of project activities to reduce emissions or sequester carbon
  - To quantify the contribution to climate change mitigation
  - Awareness of project developer or participants

Curent and future GHG emissions

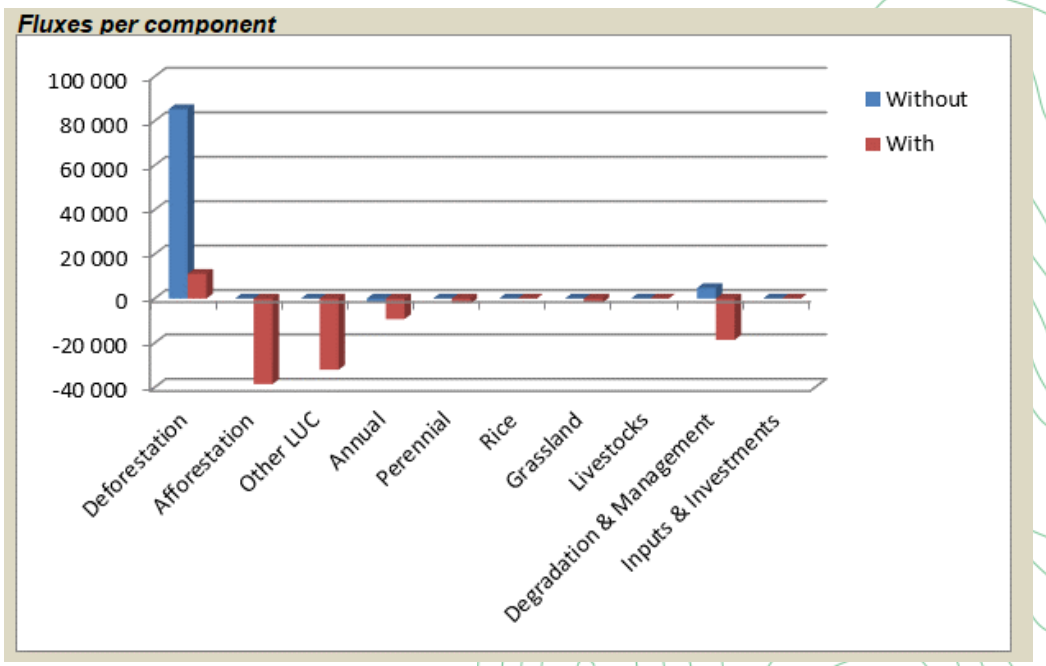
- Simple method: use of the Ex-Act tool developed by FAO

Training on the use of this tool the 24/07/2018

Curent and future GHG emissions

- Example from the FORAE Project
  - application to a land use management plan on a village of the project – prevision at 20 years
  - Main GHG benefits are linked to forest – reduction of deforestation or forest restoration.

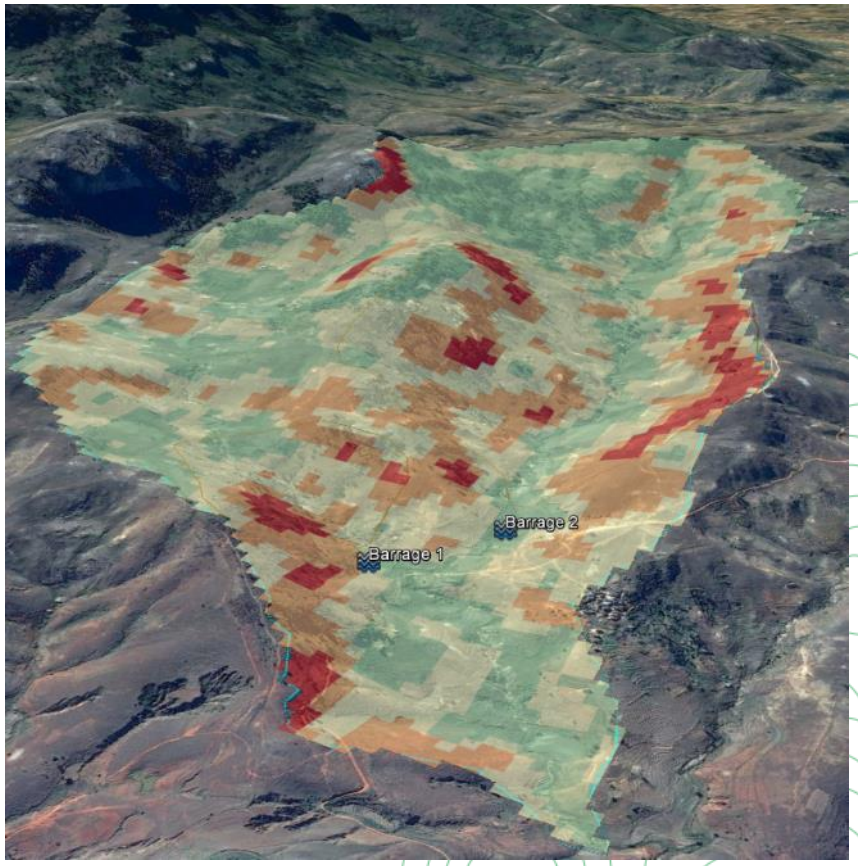
Components of the project	Gross fluxes Without	With	Balance
	All GHG in tCO2eq		
	Positive = source / negative = sink		
Land use changes			
Deforestation	85 293	11 125	-74 168
Afforestation	0	-38 460	-38 460
Other LUC	0	-32 070	-32 070
Agriculture			
Annual	-1 208	-9 239	-8 032
Perennial	0	-2 231	-2 231
Rice	0	0	0
Grassland & Livestocks			
Grassland	0	-1 737	-1 737
Livestocks	0	0	0
Degradation & Management	4 730	-18 625	-23 355
Inputs & Investments	0	0	0
Total	88 816	-91 237	**-180 053**
Per hectare	102	-105	-206
Per hectare per year	5.1	-5.2	-10.3



Erosion risk

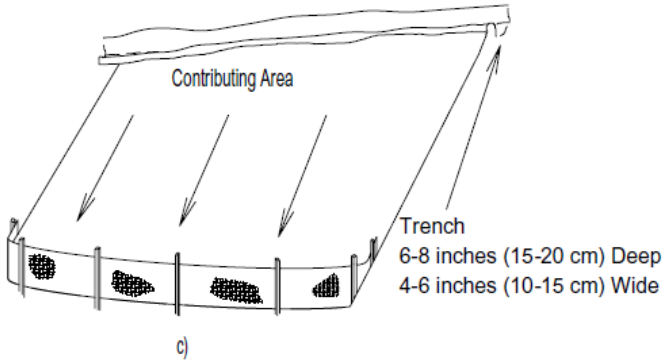
- Quantification of the quantity of soil eroded per year
- Map of the risk of erosion

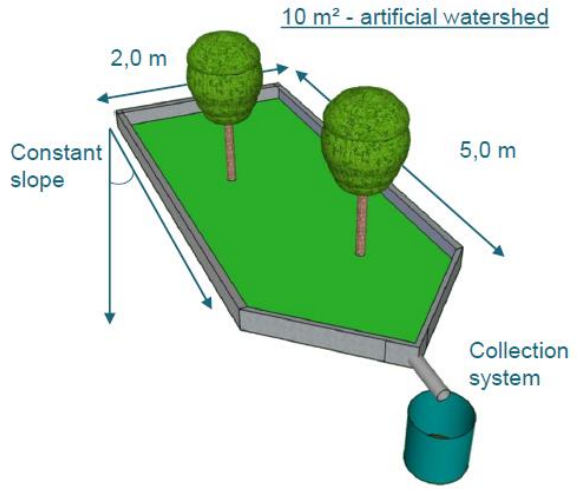
How would you use it?



Erosion risk

- Quantification of the quantity of soil eroded per year
  - Field protocols - kg of soil + water runoff
    - Need human resources for regular measurements (after each rain event)
  - ➔ impact of land cover on erosion and runoff
    - For example, does the tree plantation increase water infiltration?
    - Possible calibration of models

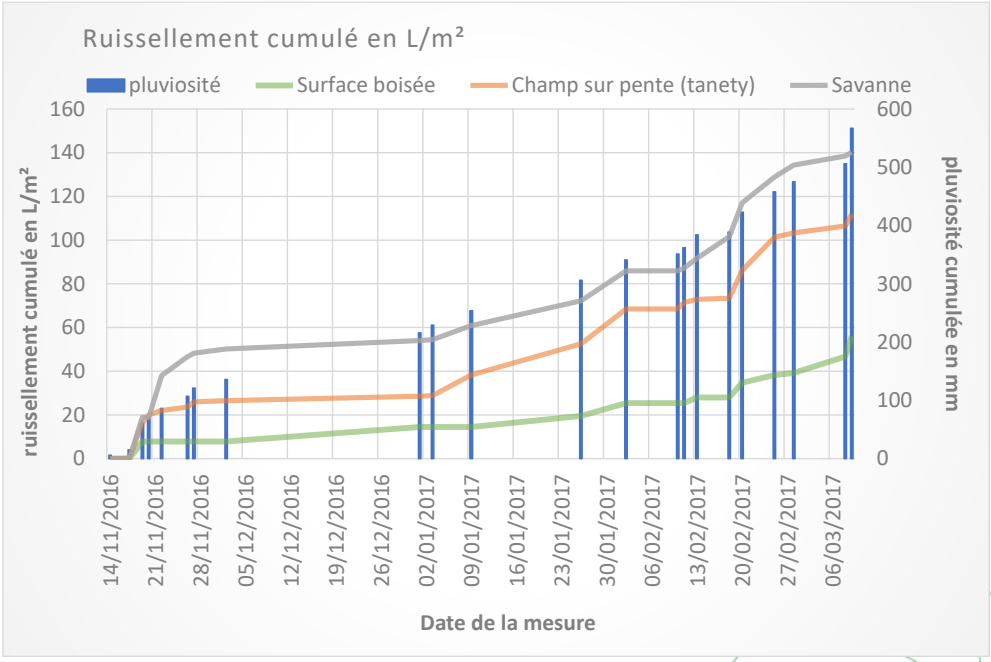


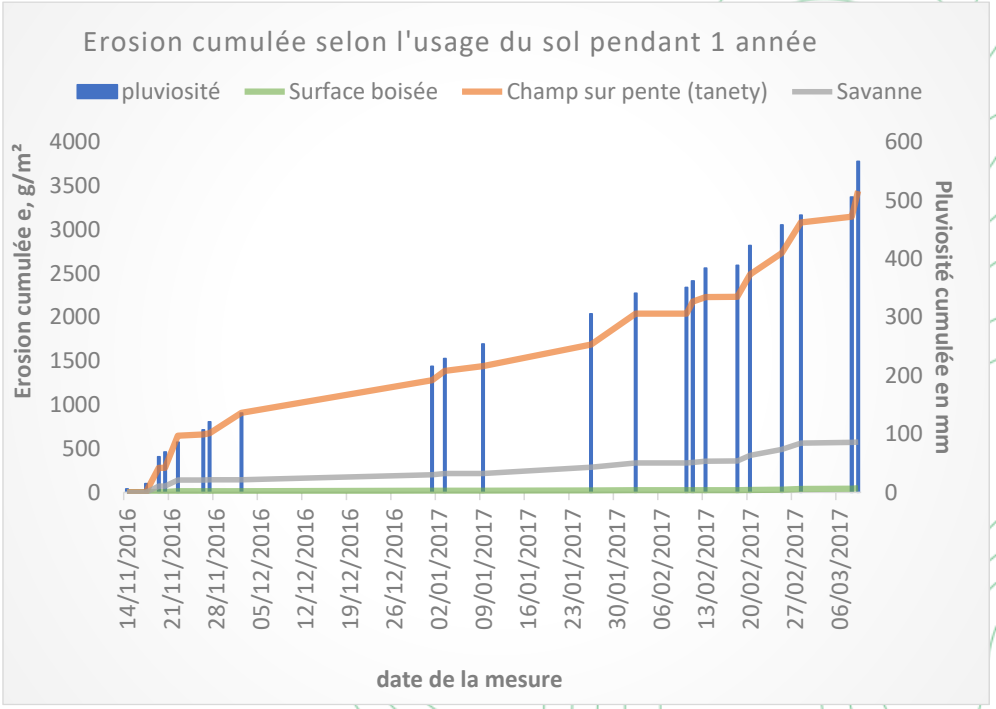


- *Fournier, F. 1954. "La Parcelle Expérimentale. Méthode D'étude Expérimentale de La Conservation Du Sol, de L'érosion, Du Ruissellement." OECE.*
- *Robichaud, P.R., and R.E. Brown. 2002. "Silt Fences: An Economical Technique for Measuring Hillslope Soil Erosion." USDA.*

Erosion risk

- Quantification of the quantity of soil eroded per year
  - Example on another project (Madagascar – nitidæ + ASI)
  - Erosion on 3 land covers





Erosion risk

- Map of erosion risk
  - Example on another project (Madagascar – nitidæ + ASI)
  - RUSLE (Revised Universal Soil Loss Equation) method
    - Possibility of quantification

A= R K LS C P

A: **soil loss** T/ha/an
R: rain erosivity
K: soil erodibility

LS: slope factor
C: factor related to land cover
P: index representing anti-erosion structures

Erosion risk

A= R K LS C P

A: **soil loss** T/ha/an
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- Map of erosion risk
  - Example on another project (Madagascar – nitidæ + ASI)
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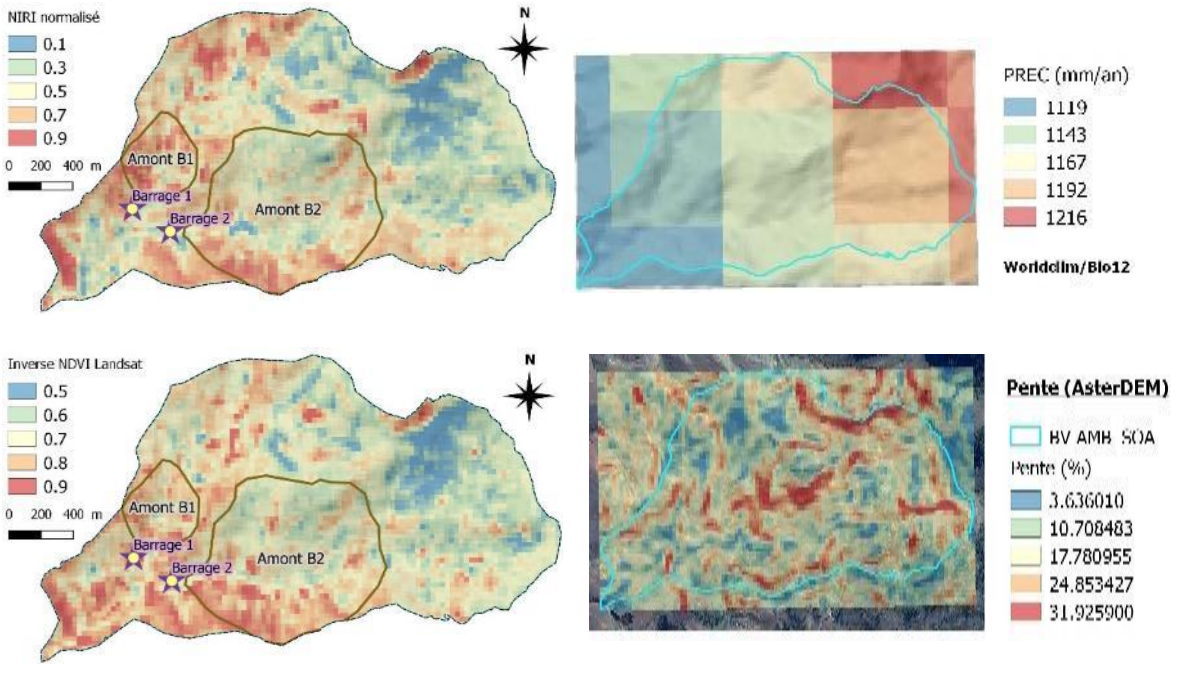
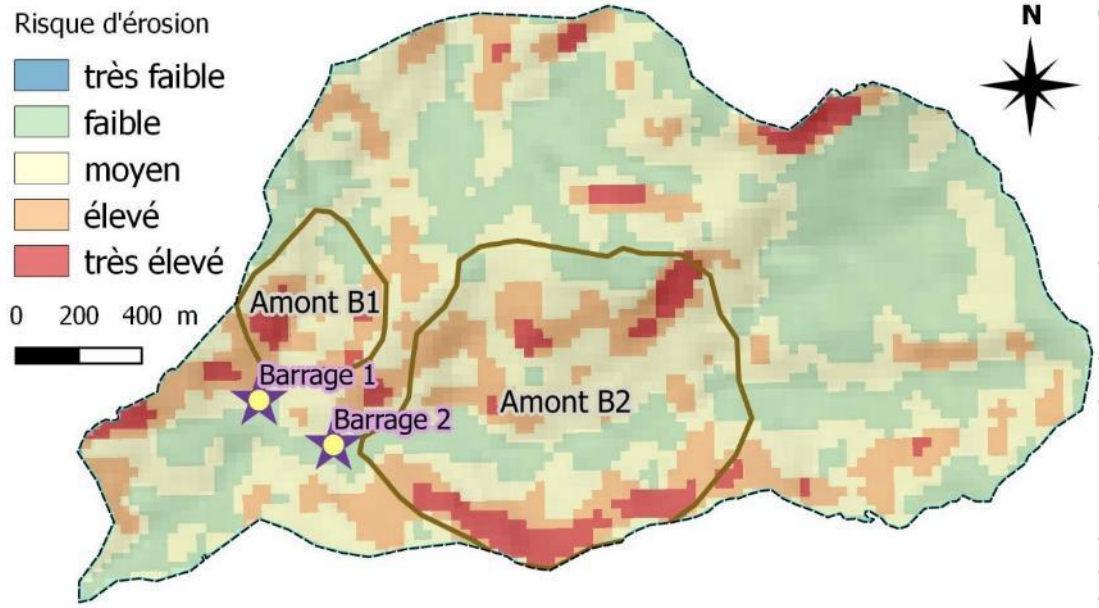
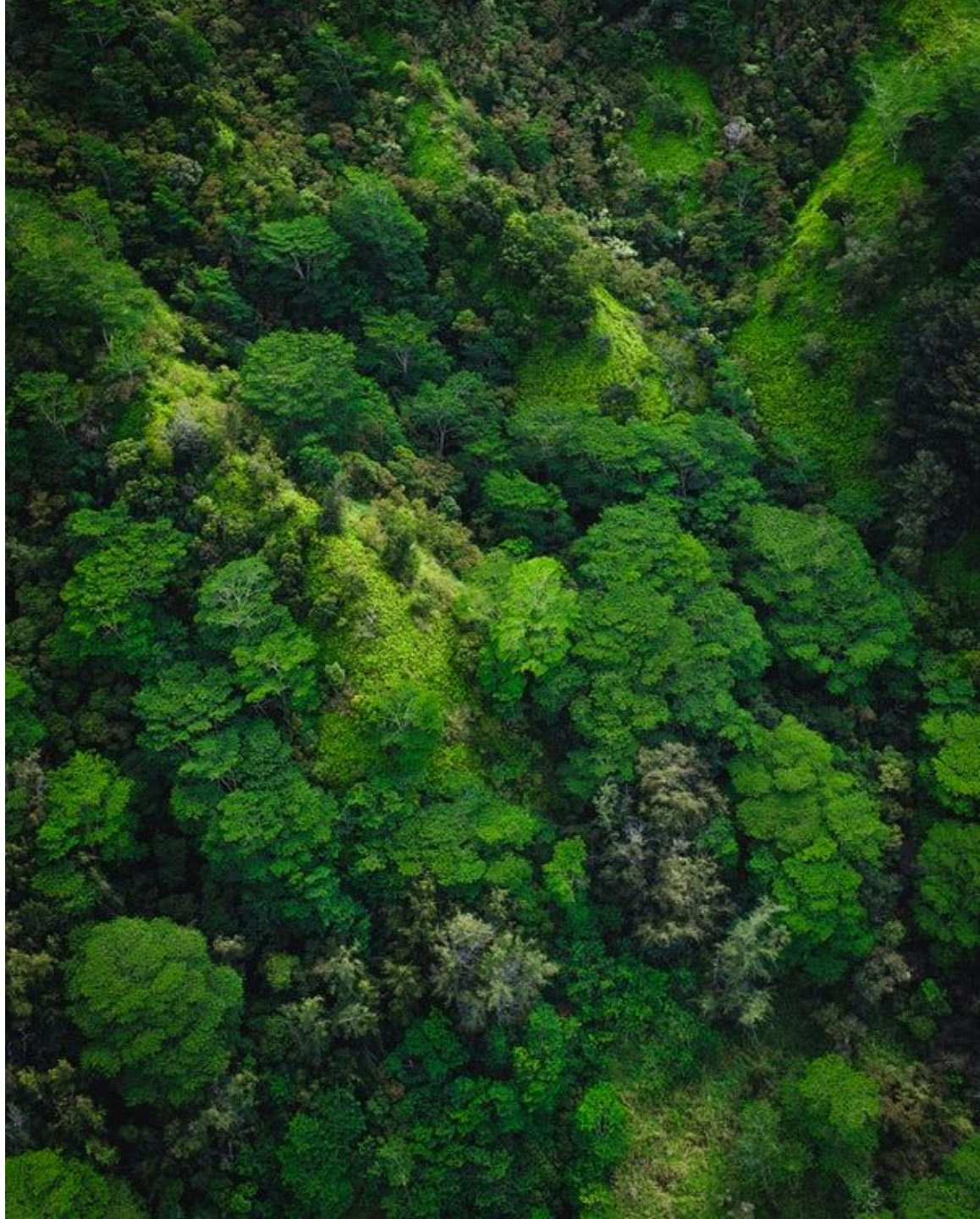




Forest biodiversity

- Objective : Knowledge of the biodiversity existing on your territory
  - Flora and/or fauna

How would you use it?



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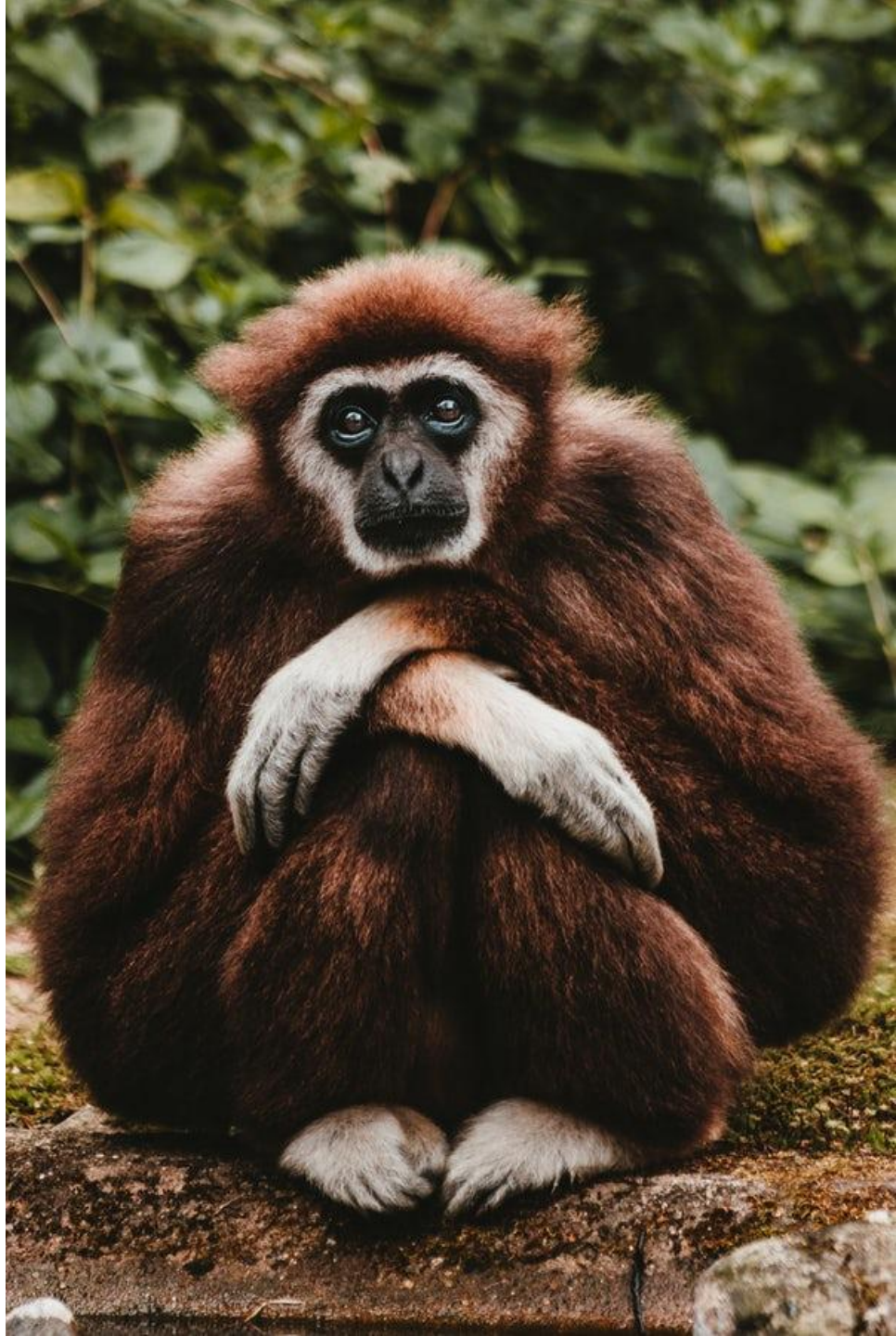
Forest biodiversity

- Objective : Knowledge of the biodiversity existing on your territory
  - Flora and/or fauna
    - Identification of areas that should be protected
    - Identification of species with protection status or threatened
    - Identification of useful species and their abundance
    - Assessment of habitat connectivity/fragmentation to direct project activities
    - Evaluation of the impact of the project if inventories are done regularly



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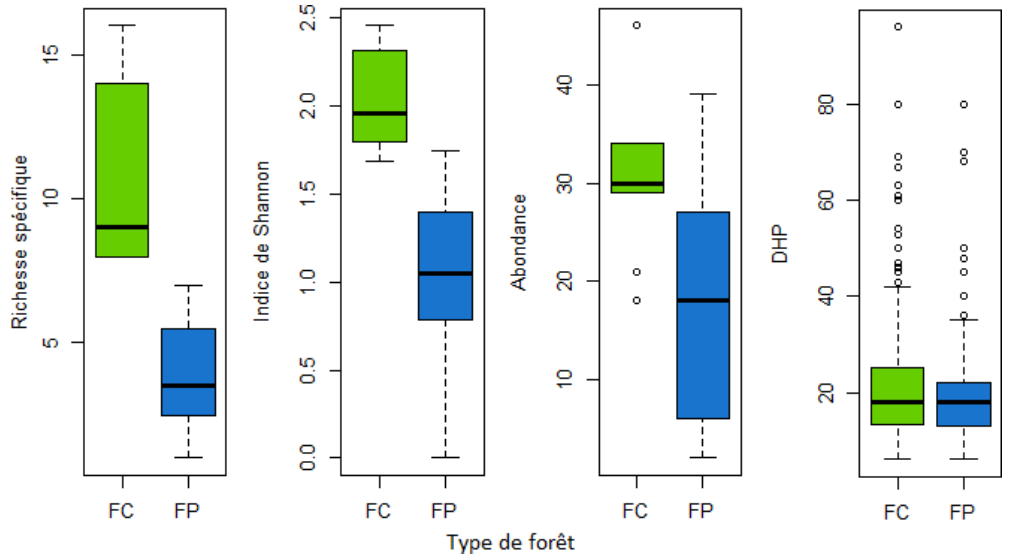
Forest biodiversity


Azfelia xylocarpa seeds

- Objective : Knowledge of the biodiversity existing on your territory
  - Example on FORAE project – tree biodiversity
  - Method : forest inventory



Threatened species	Statut IUCN
Afzelia xylocarpa (Kurz) Craib	EN
Bauhinia variegata L.	LC
Cratoxylum cochinchinense (Lour.) Blume	LC
Dimocarpus longan Lour.	NT
Engelhardtia serrata Blume	LC
Nephelium lappaceum L.	LC

Carbon stocks

- Objective : knowledge of forest biomass and of emissions related to deforestation or forest degradation
  - Method : result of the forest inventory
    - Example from the FORAE project

Measure of Diameter at breast height (DHP), identification of species and reporting

Estimation of the height of the tree

Forest Type	AGB	BGB	Total
biomass in tC/ha			
Conservation	82.73 (± 73.3)	16.55 (± 14.6)	101,05 (± 91.3)
Protection	31.20 (± 32.8)	6.24 (± 6.6)	37.44 (± 39.4)
biomass in tCO_2eq/ha			
Conservation	303.34 (± 268.7)	67.19 (± 66.3)	370.5 (± 334.9)
Protection	114.41 (±120.4)	22.88 (±24.1)	137.29 (± 144.5)

Water flows

- Objective: knowledge of the temporal evolution of the water flows at sources or outlet of watershed – variation according to land cover

How would you use it?

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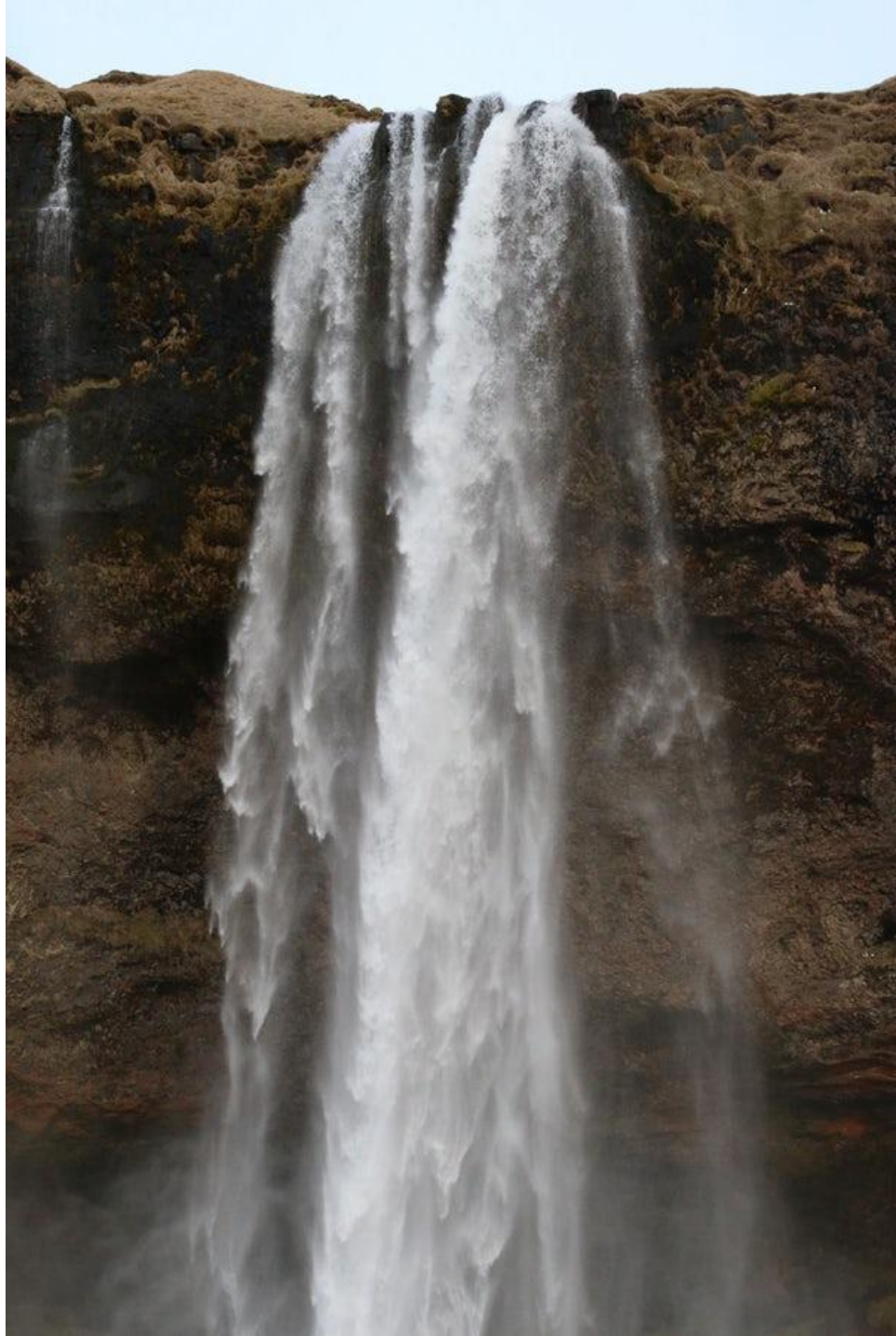
Water flows

- Objective: knowledge of the temporal evolution of the water flows at sources or outlet of watershed – variation according to land cover
  - Impact of the project on sources water flows if there are changes on land cover above sources
  - Monitoring of the impact of climate change on water sources to assess if adaptation measures will be necessary



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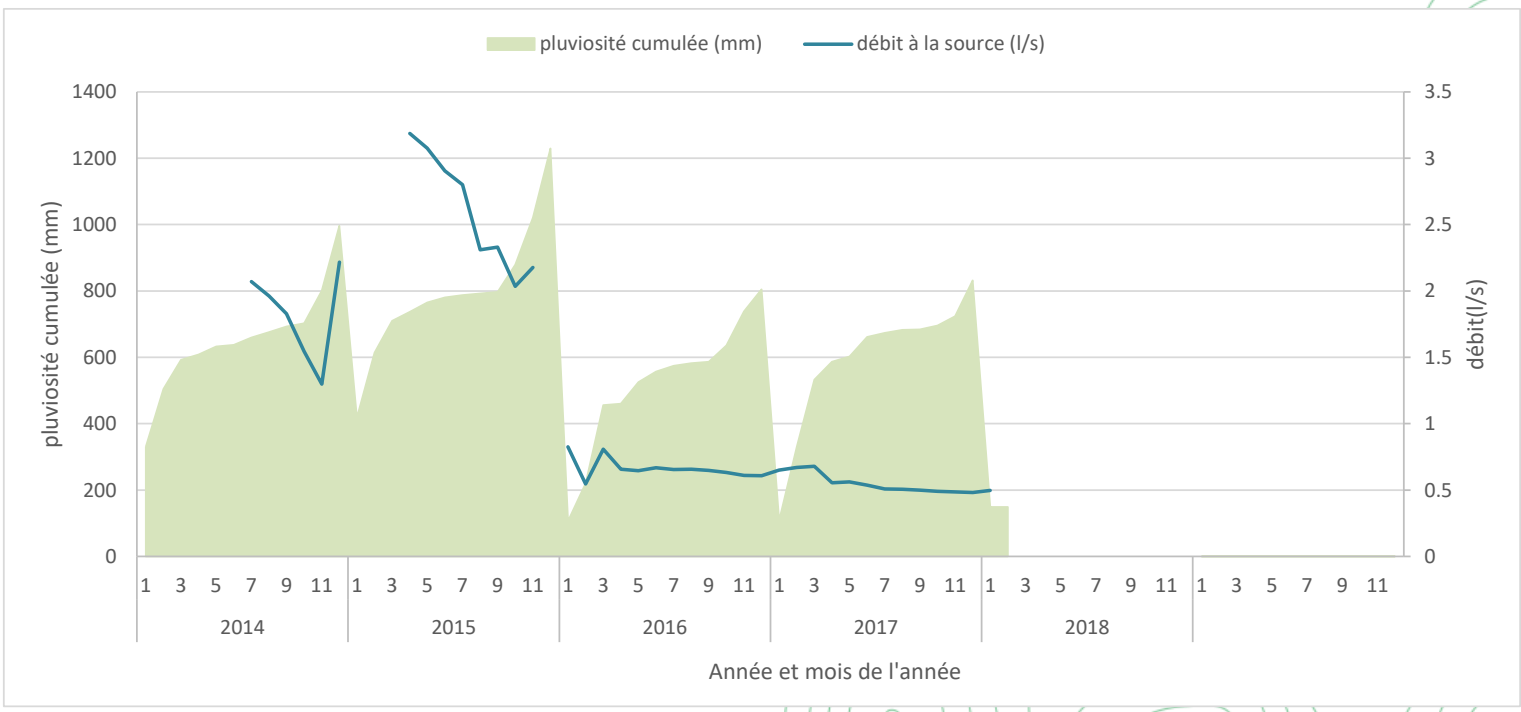
Water flows

- Objective: knowledge of the temporal evolution of the water flows at sources or outlet of watershed – variation according to land cover
  - Method: simple measurement of water flows with a bucket and chronometer (1 measure per week)

- Example on another project (Madagascar - Kolorano - nitidae & ASI)
- Impact of a catchment, of droughts and of fires above the source



Soil fertility

- Objective : knowledge of the spatial (and temporal) variability of soil fertility and carbon stocks

How would you use it?

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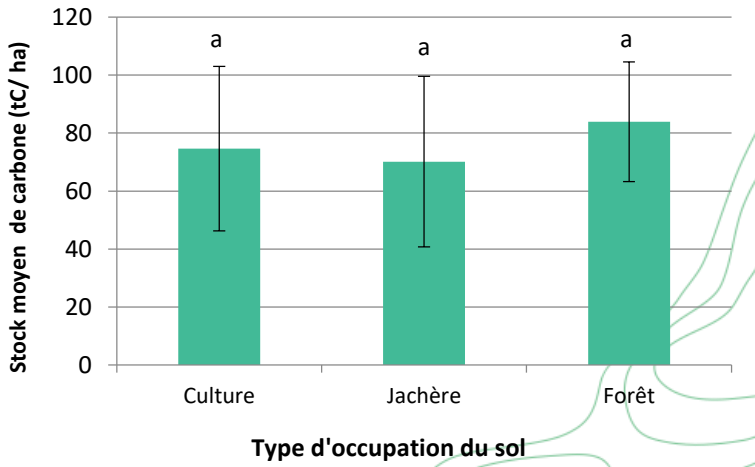
Soil fertility

- Objective : knowledge of the spatial (and temporal) variability of soil fertility and carbon stocks
  - To target areas for activities related to soil fertility improvement
  - To assess emissions/sequestration of carbon in the soil due to the project
  - To evaluate the impact of the project on the long term

Soil fertility

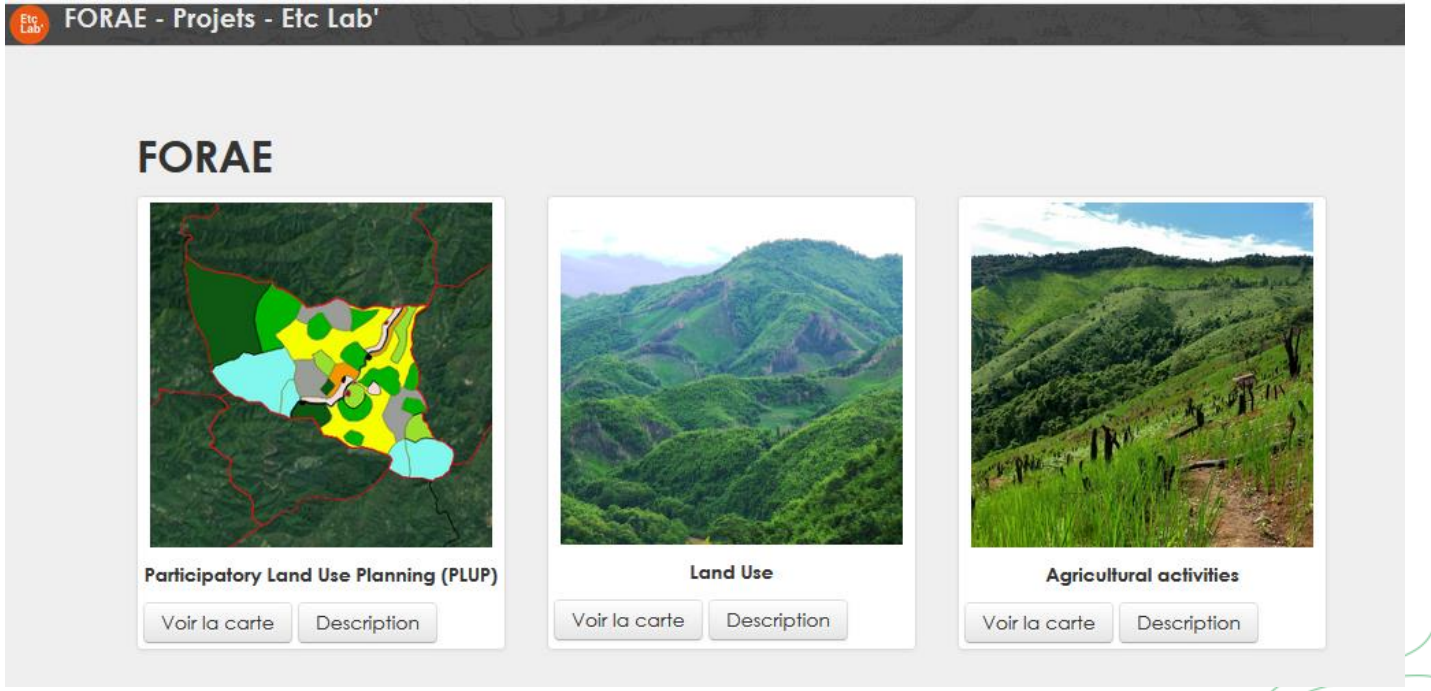
- Objective: knowledge of the spatial (and temporal) variability of soil fertility and carbon stocks
  - Method: soil inventory – pits at several places in plots
  - Example of FORAE project: not conclusive according to land cover



Web portal – monitoring tool

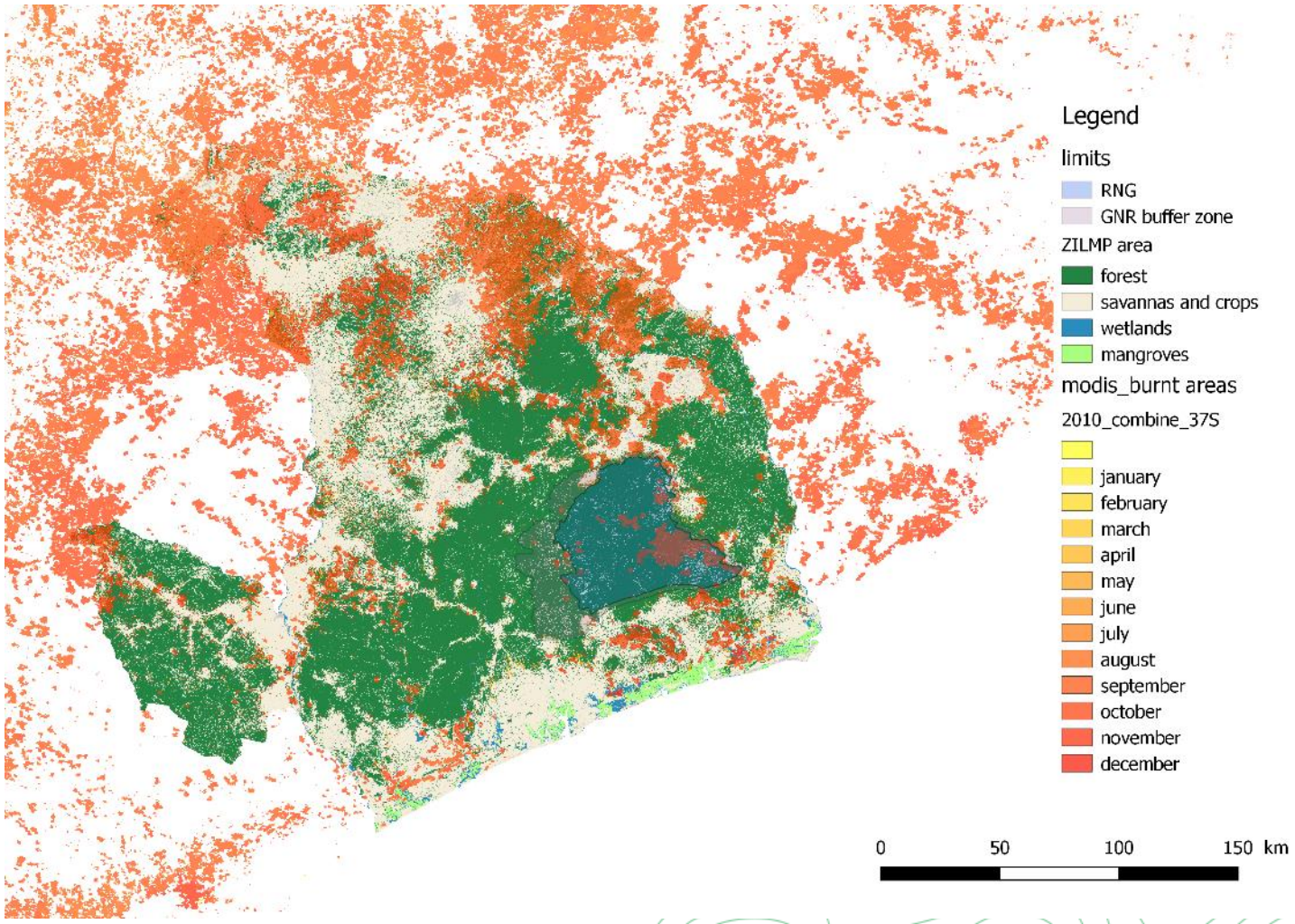
- Example from the FORAE project:

www.forae-viengkham.com



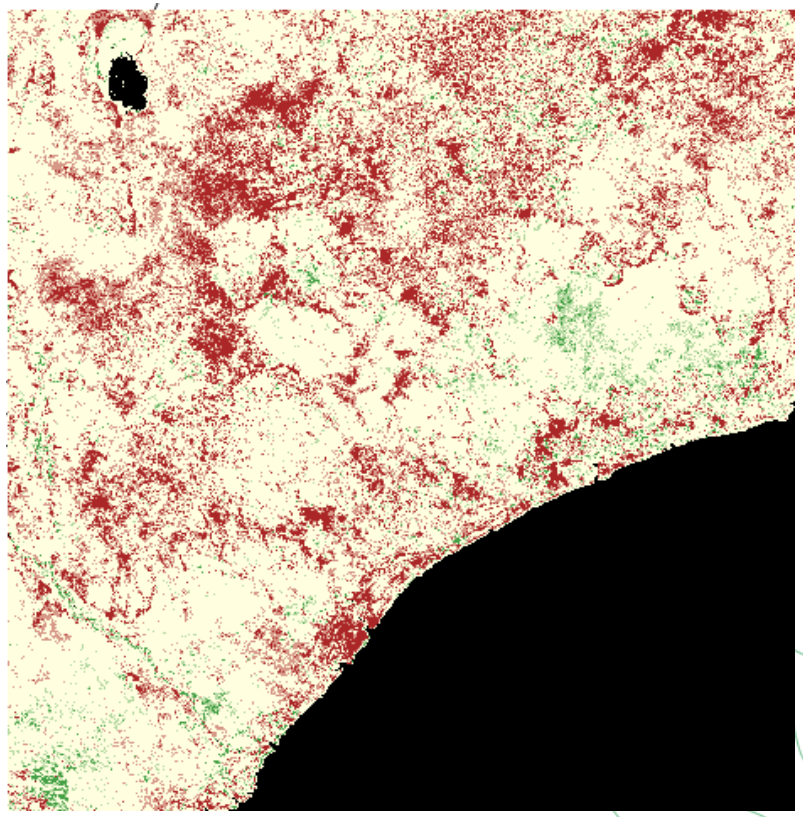
Other possible components

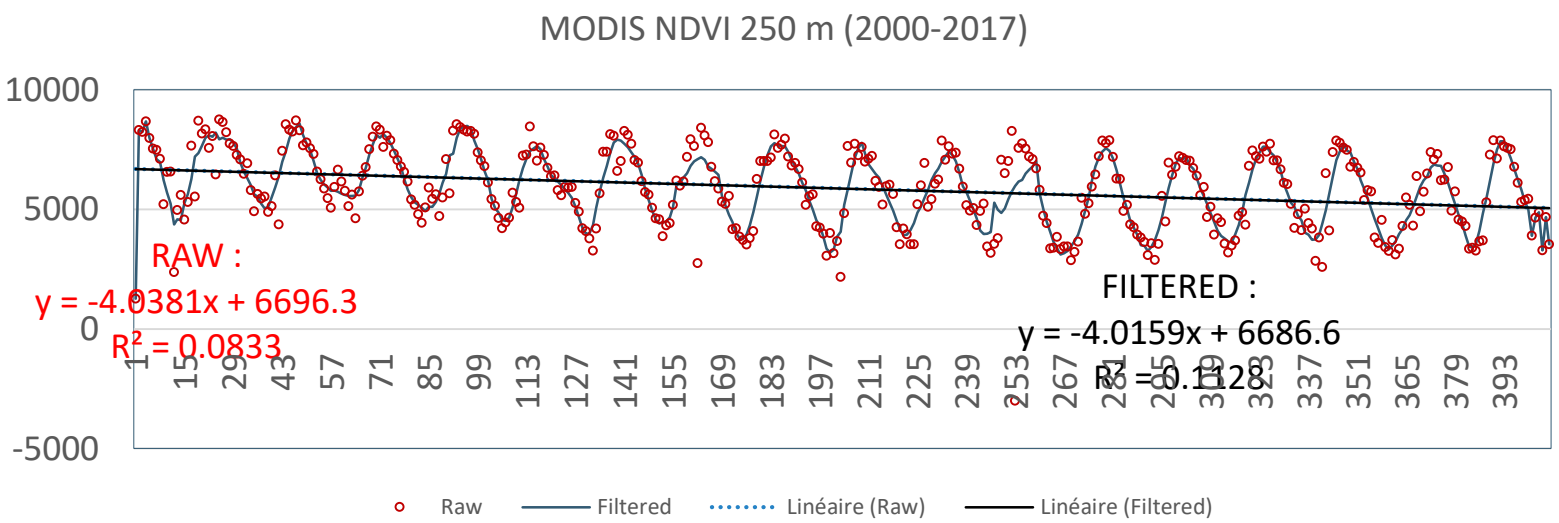
- Monitoring of fires
  - Example around a reserve in Mozambique



Other possible components

- Monitoring of fires
- Land productivity trends
  - Example around a reserve in Mozambique





Thank you for your attention

Questions ?

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www.nitidae.org

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