ESA Forest Carbon Monitoring project – How to improve the usability of EO based approaches for users' evolving requirements in forest biomass monitoring

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Project objective

- To improve remote sensing based approaches to meet users' needs in forest carbon monitoring.
- To develop and test a cloud processing platform for forest carbon monitoring.
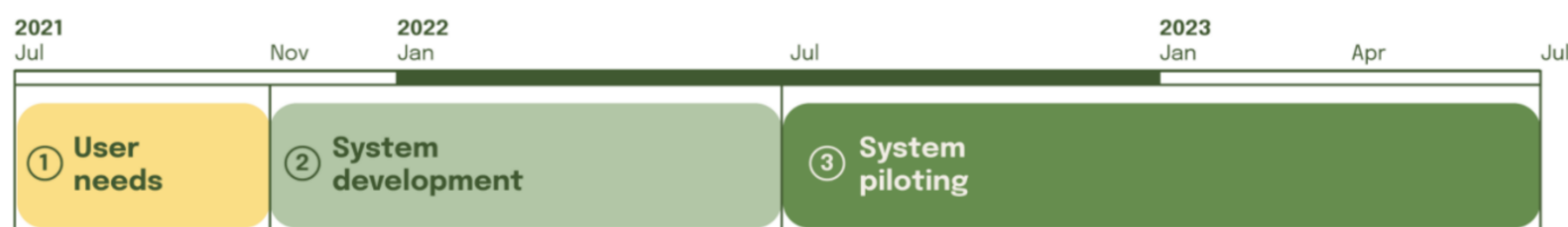- The project duration is two years.

Figure 1. Forest Carbon Monitoring project timeline

- User interviews and underlying policy analysis (Figure 1) defined the target requirements that the project aims to meet.

Table 1. Synthesis of key user requirements by demonstration type

	Demo 1: Local	Demo 2: Provincial/National	Demo 3: Continental
Product requirements	Basic forest structure variables, carbon state and change mapping	Basic forest structure variables, maps of aboveground forest biomass stocks and changes	Maps of aboveground forest biomass stocks and changes
Interest area	Companies' forest estates	Regions and whole countries	Europe (EU27)
Spatial detail	10 to 20 meters	10 to 100 meters	100 meters
Temporal Resolution	Annually	Annual/every two years	Annual/every two years
Forest variables of interest	Height, Basal area, Diameter, Species proportion, Above and Below Ground Biomass	Height, Basal area, Diameter, Species proportion, Above and Below Ground Biomass	Above Ground Biomass
Accuracy	Variable requirements, for pixel to stand level area	Variable requirements, for pixel to country level area	Pixel level uncertainty; aggregate at 0.1 degree; compared with NFI statistics

High level framework of the platform

1. Close integration of in-situ and remotely sensed data.
2. Process-based forest ecosystem (PREBAS) modelling integrated into the system.
3. Flexibility to user needs ranging from private companies to continental analyses.
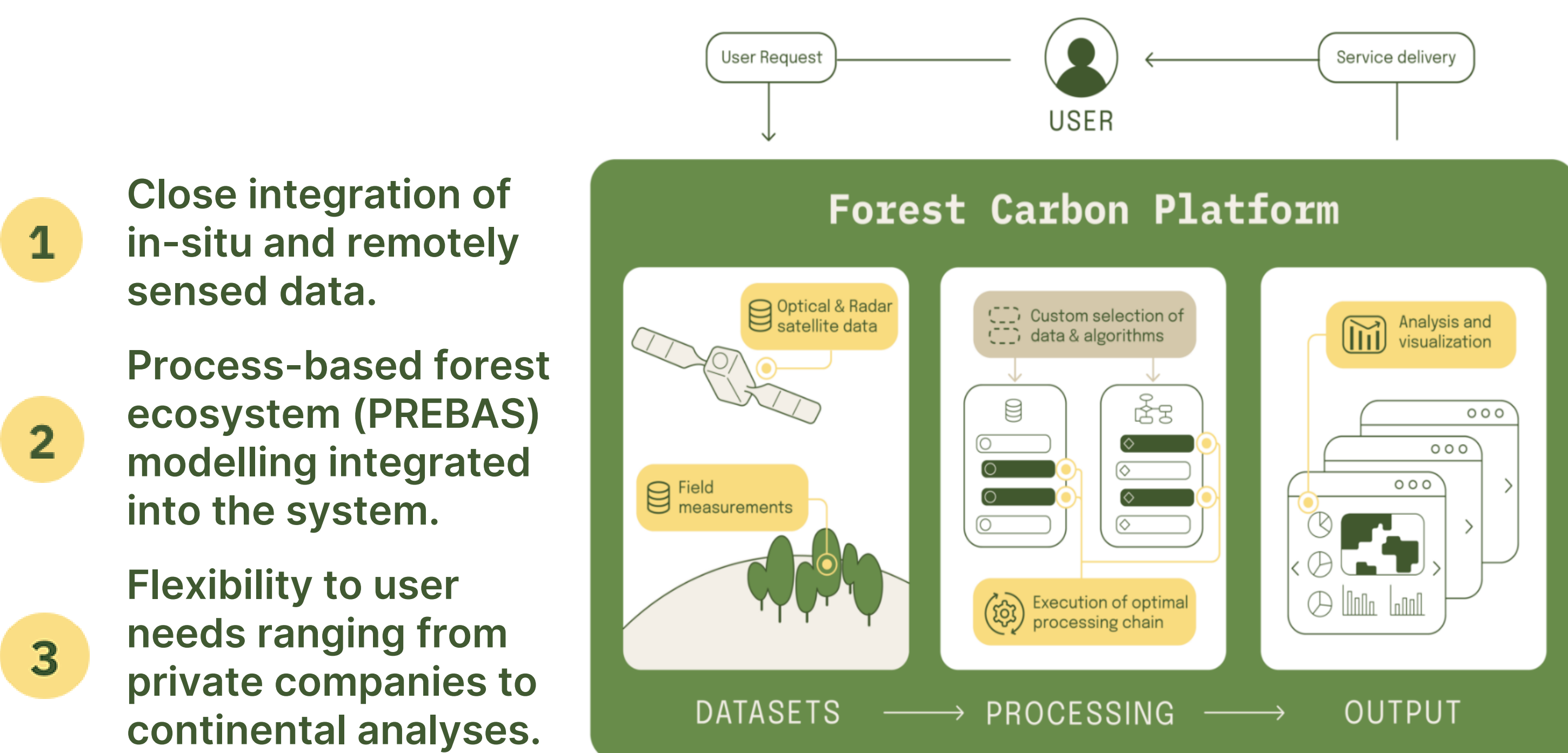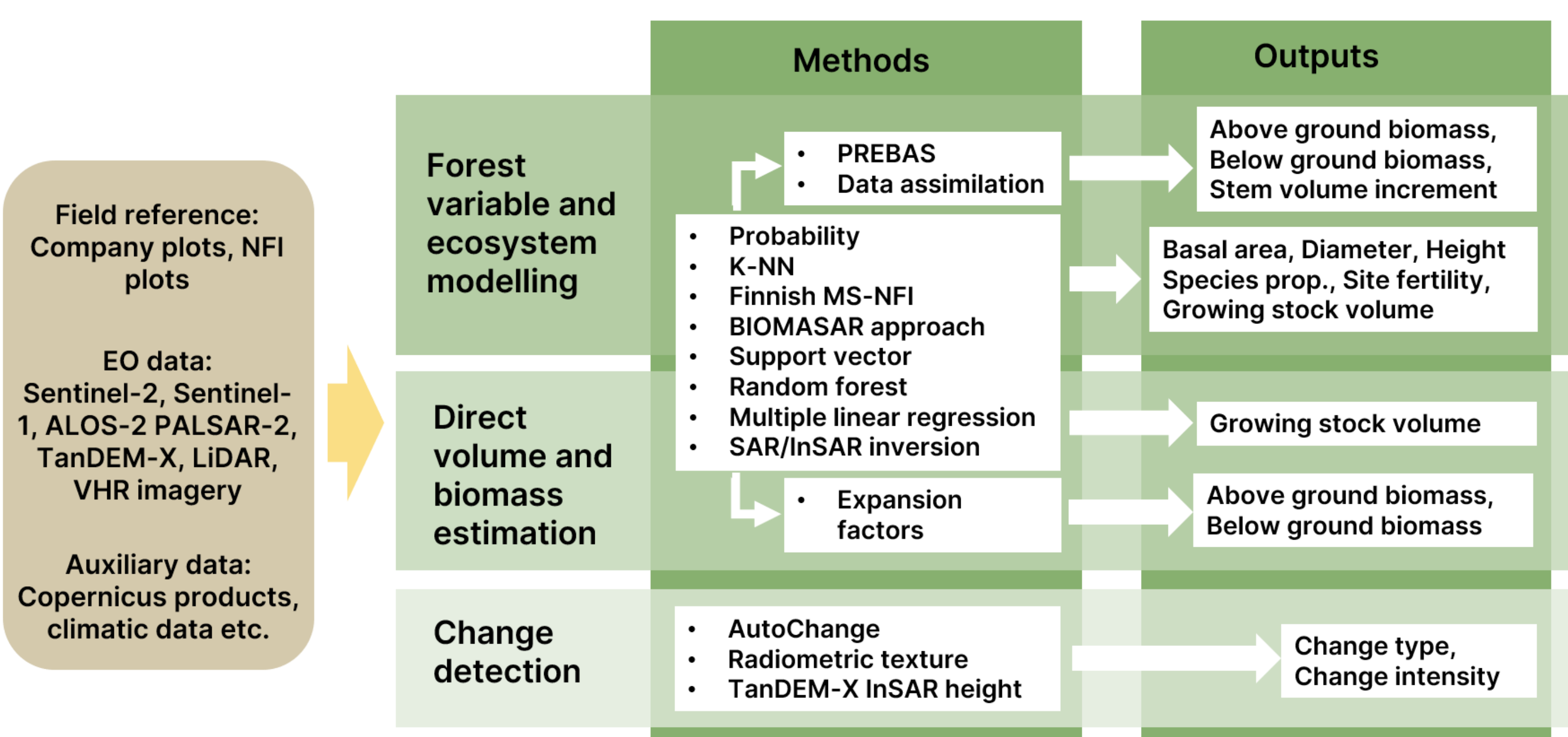
Figure 2. High level platform framework

Figure 3. Main processing paths in algorithm comparison and evaluation

Testing and demonstration sites

- Seven sites for algorithm tests during the first year. Full-scale demos during the second year.
- Local demos (1) to meet private company needs.
- Provincial/national demos (2 and 4) for administrative agencies.
- Continental demo (3) for international organizations.
- Tropical Peru site allows investigation for future expansion of the forest carbon platform concept beyond European conditions.
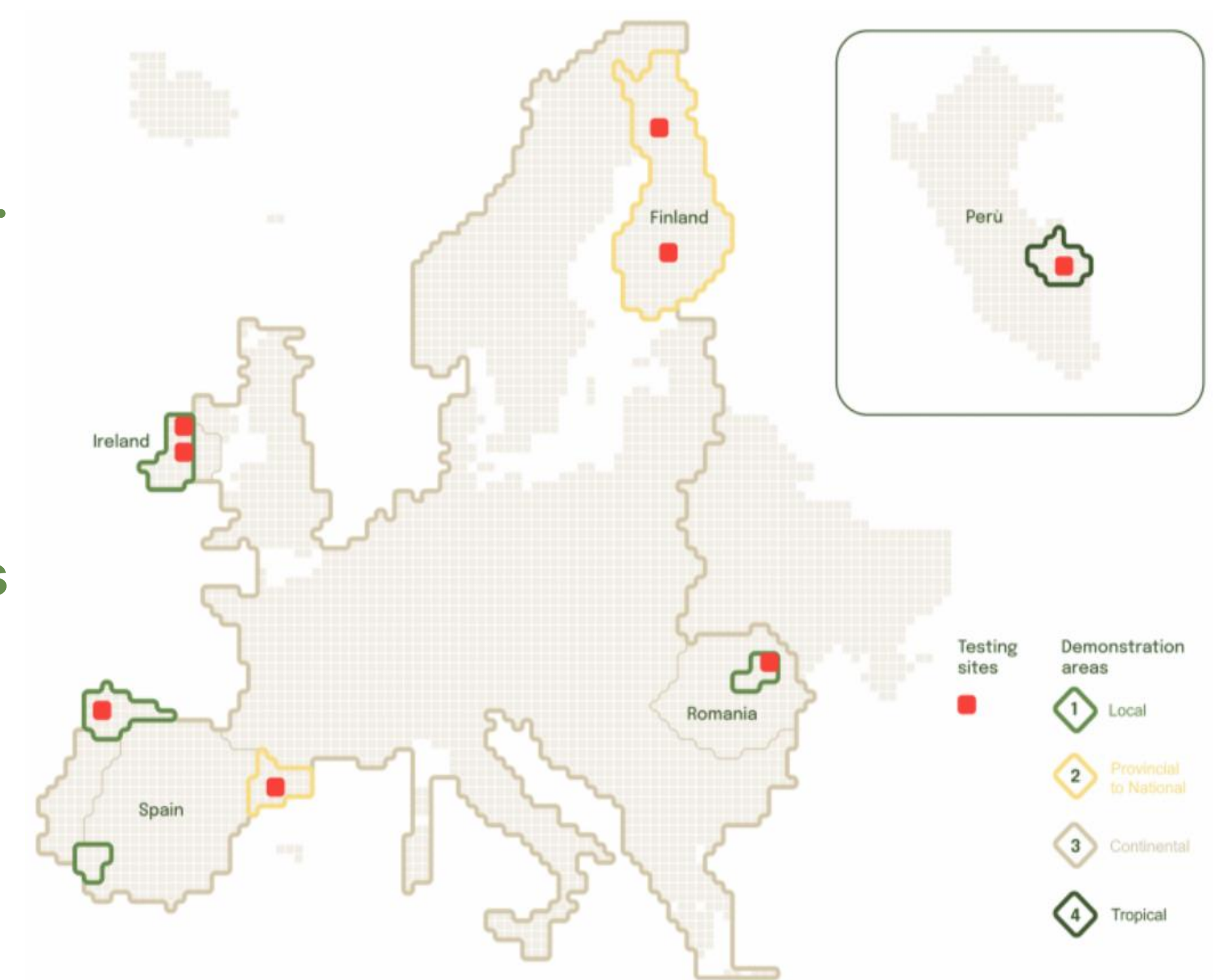

Figure 4. Testing and demonstration locations

Early results

- Sentinel-1 and -2 pre-processing for the European demo completed.
- Satellite dataset fusion comparison nearly completed, advocating use of X-band coherence.

Datasets	RMSE*
Sentinel-1 only	50-80%
Sentinel-2 only	20-60%
Sentinel-2 + Sentinel-1 or PALSAR2	20-60%
Sentinel-2 + Sentinel-1 + TanDEM-X coherence	20-50%

Figure 5. Plot level accuracy variation between variables and sites in 10 m products. RMSE percent of the mean.
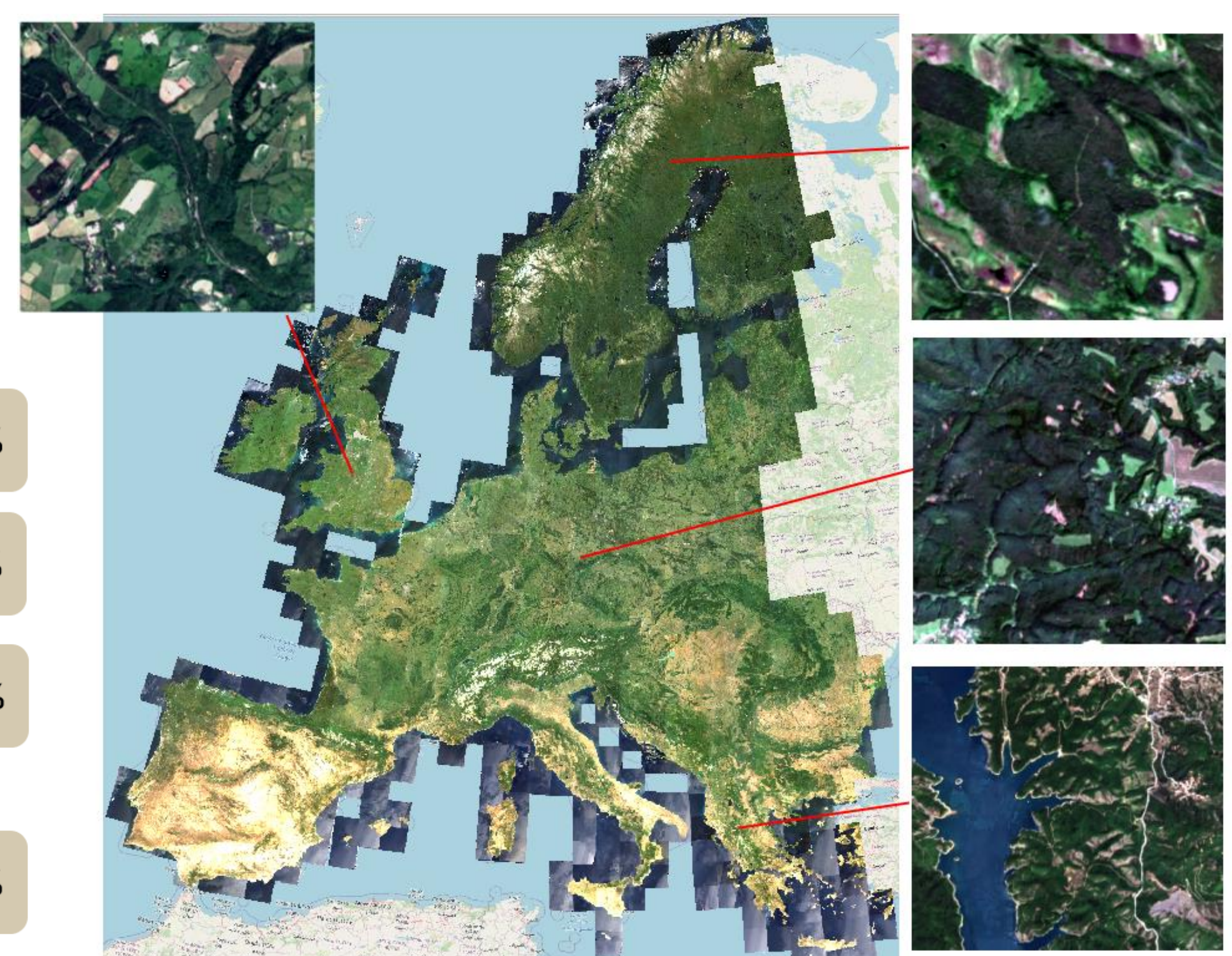

Figure 6. Sentinel-2 composite image mosaic for 2021

- Initial decision tree for method selection for the Forest Carbon Monitoring platform has been designed. The approach will be tested in the demonstration phase.
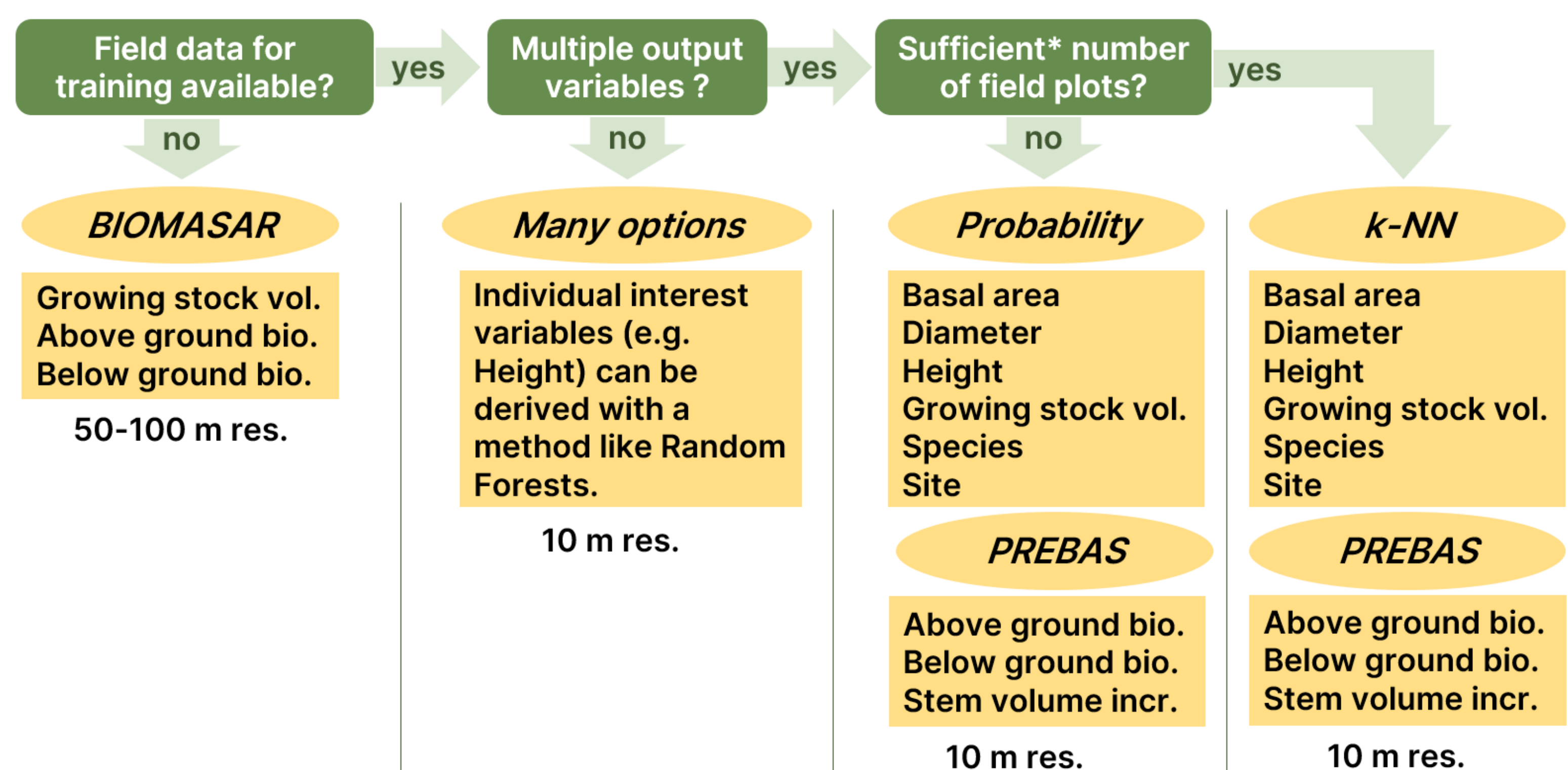

Figure 7. Initial decision tree for method selection for the Forest Carbon Monitoring platform

*Typically at least 100 plots

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