LIFE14 ENV/IT/000414
Demonstrating Remote Sensing integration in sustainable forest management
FRESh LIFE

ACTION E3
Second version
Indicators

Deliverable
List of indicators with analysis of remote sensing contribution

Firenze,
15/11/2019

Summary

Aims

This action is aimed to compile the information needed to complete the indicator tables (quantitative and qualitative) that will be submitted with the first Progress and Final Reports. For each selected indicator we will evaluated how remote sensing technologies can contribute in supporting the sustainable forest management.

The action is under responsibility of the coordinating beneficiary that acquire information from the responsible beneficiaries in the three demonstration sites also trough the compilation of questionnaires, meetings and field visits.

Milestones e deliverables

In the Action E3, the following milestones and deliverables are expected:

Name of the milestone	*Deadline*
M1 – Definition of the indicators	31/12/2017

Name of the deliverable	*Deadline*
D1 – Indicators submitted with First Progress Report	30/06/2016
D2 – List of indicators with analysis of remote sensing contribution	31/12/2018
D3 - Indicators submitted with Final Report	30/11/2019

Progress

Starting from what indicated in the project proposal we defined the indicators and submit it with the first progress report in line with the deliverable "Indicators submitted with First Progress Report". The project indicators were validated following the indications provided by the monitoring team NEEMO. The online form was compiled by indicating all the indicators considered relevant for the project activities. According to the project timetable the indicators will be compiled again at the end of the project when all the impacts will be more evident and quantifiable.

Selected indicators are the follow:

- 1.5 Project area/length;
- 1.6 Humans (to be) influenced by the project;
- 4.2.1 Sustainable Forest Management;
- 4.2.2 Provision of forest datasets for the European Data Centre;
- 7.3 Natural and semi-natural habitats;
- 11.1 Website;
- 11.2 Other tools for reaching/raising awareness of the general public;
- 12.1 Networking;
- 12.2 Professional training or education;
- 13. Jobs;
- 14.1 Running cost/operating costs during the project and expected in case of continuation/replication/transfer after the project period;
- 14.2.1 Capital expenditure expected in case of continuation/replication/transfer after the project period;
- 14.3 Future funding;
- 14.4.3 Entry into new geographic areas;

Here below we analyze the remote sensing contribution to each of these indicators. However it is important to underline that not all indicators are directly related to the technologies and methodologies proposed by our project so quantify the contribution of remote sensing could be result harder.

1.5 Project area/length

At the end of the project the conservation or improvement of the status of the project area in the specific contexts has been reached. In the demonstration site of Rincine (Specific context: Continental Firenze), the methods used by FRESh LIFE project to map SFM indicators with remote sensing technologies will be extended from the area of the demonstration site to a larger area in order to update the new forest management plan for all the forest managed by UCVV. Thus, 5 years beyond we can expect that in Rincine the conservation or improvement of the status of the project area will cover about 800 ha. In addition, the approach developed by FRESh LIFE project to map the growing stock volume has been replicated in the Nature Reserve of Vallombrosa over an area of about 1200 ha to update the forest management plan of the Reserve and to create a Forest Information System.
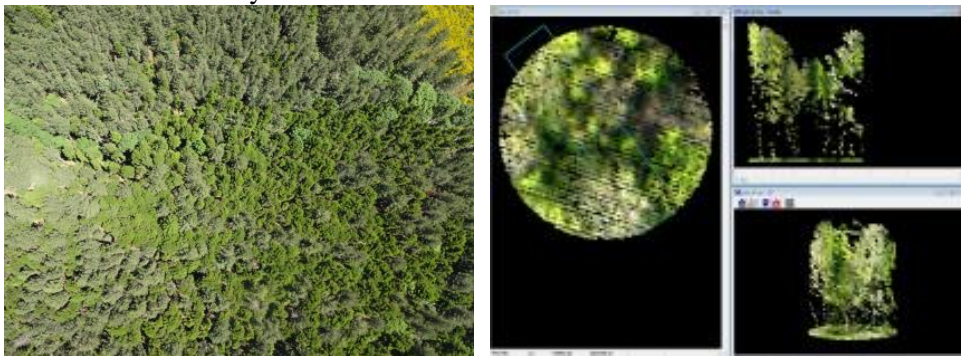

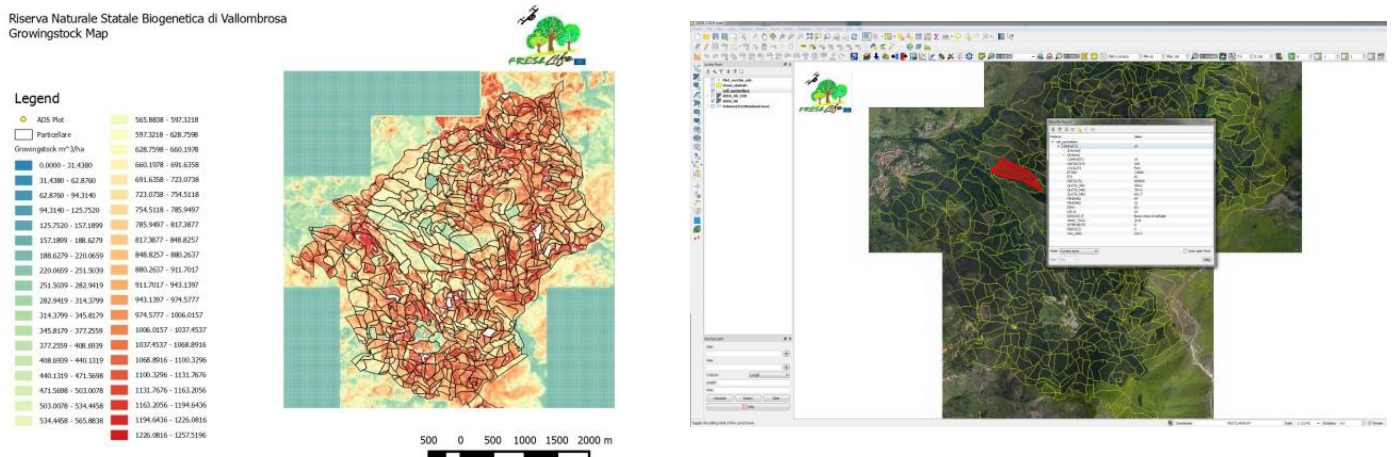*Fig. 1 - Remote sensing data acuired by ebee UAV in Vallombrosa Natural Reserve*

Fig. 1 – Vallombrosa Growing Stock Map and FIS

1.6 Humans (to be) influenced by the project

The use of new remote sensing technologies proposed by our project for forestry applications, specially the use of UAV, have a great appealing for forest operators but also for students and the citizens of the demonstration sites. For this reason, the number of humans influenced by the project was high. This indicator has been quantified taking into account the total number of participants to demonstration flights at the end of the project (Tab.1).

Type of event	2015	2017	2018	2019
	Num.	Num.	Num.	Num.
Demonstration flights	0	260	100	50
Seminars	0	100	300	400
Networking	0	150	200	250
Other demonstration events	0	200	200	300
Count	0	710	800	1000

Table 1. Number of individuals reached by demonstration events (demonstration flights and seminars) and networking (updated on December 2019).

4.2.1 Sustainable Forest Management

The objective of adapting forest management to sustainability criteria has been reached in each specific context. At the end of the project, the area of all demonstration sites is managed based on the SFM approach. In the site of Rincine (Specific context: Continental Firenze) the area under SFM has been extended from the area of the demonstration site to a larger area of about 730 ha (Tab. 5, section 6.4) using the methods implemented by FRESh LIFE project to map SFM indicators for the entire forest managed by UCVV. For this reason, 5 years beyond we can expect that in Rincine the area under SFM will cover about 800 ha.
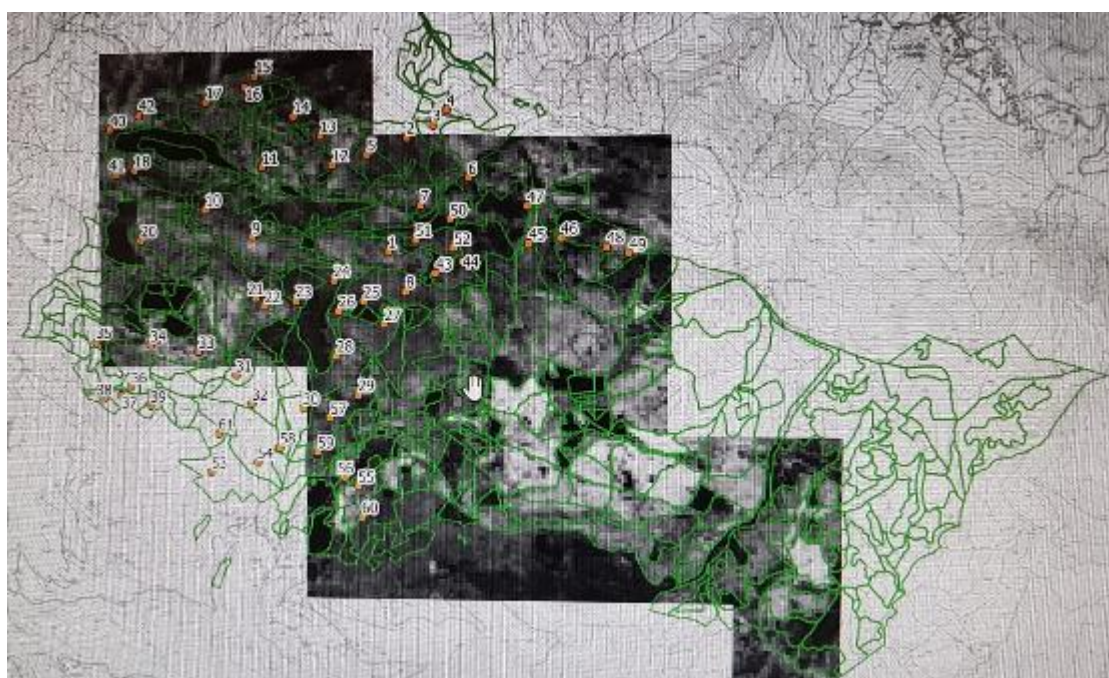

Figure 14. Field surveys extension out from the demonstration site in Rincine to cover the area of the new forest management plan

4.2.2 Provision of forest datasets for the European Data Centre

The target of providing forest datasets for the European Data Centre has been reached in each demonstration site. As reported in Tabs. 2-5 a total of 6 SFM indicators has been taken into account for mapping purposes in each specific context, and a map for each SFM indicator has been provided in each demonstration site. In the site of Rincine (Specific context: Continental Firenze) 7 SFM indicators have been mapped, including the indicator Naturalness, which was not considered in remaining sites because no introduced tree species were present. The number of forest datasets provided for the European Data Centre ranges between 7 in the sites of Bosco Pennataro and Caprarola and 8 in the site of Rincine Tab 5. All the data set produced by our project are correlated with metadata following the INSPIRE instructions that facilitate their use in the European context.

SFM indicator	Map							
	2015		2017		2018		2019	
	Yes	No	Yes	No	Yes	No	Yes	No
European Forest Types	0	1	1	0	1	0	1	0
Growing stock	0	1	1	0	1	0	1	0
Age structure and/or diameter distribution	0	1	0	1	1	0	1	0
Forest damage	0	1	1	0	1	0	1	0
Tree species composition	0	1	1	0	1	0	1	0
Naturalness (Area covered by introduced tree species)	0	1	0	1	1	0	1	0
Deadwood (Aboveground Biomass)	0	1	0	1	1	0	1	0
Count	0	7	7	0	7	0	7	0

Table 2. Number of SFM indicators taken into account for mapping purposes

SFM indicator	2015	2017	2018	2019
	ha	ha	ha	ha
European Forest Types	0	793	793	793
Growing stock	0	276	793	793
Age structure and/or diameter distribution	0	0	793	793
Forest damage	0	793	793	793
Tree species composition	0	793	793	793
Naturalness (Area covered by introduced tree species)	0	0	276	276
Deadwood (Aboveground Biomass)	0	0	793	793
Count	0	2379	5034	5034

Table 3. Forest area mapped per each SFM indicator

Methods	Map							
	2015		2017		2018		2019	
	Yes	No	Yes	No	Yes	No	Yes	No
European Forest Types classification	0	1	1	0	1	0	1	0
Growing stock assessment	0	1	1	0	1	0	1	0
Age structure and/or diameter distribution assessment	0	1	0	1	1	0	1	0
Forest damage assessment	0	1	1	0	1	0	1	0
Tree species composition classification	0	1	1	0	1	0	1	0
Naturalness classification	0	1	0	1	1	0	1	0
Deadwood assessment	0	1	0	1	1	0	1	0
Count	0	7	4	3	7	0	7	0

Table 4. Number of proposed methods suitable for operational use in forest management planning (high-cost effectiveness)

Data	Map							
	2015		2017		2018		2019	
	Yes	No	Yes	No	Yes	No	Yes	No
Inventory plots	0	1	3	0	3	0	3	0
Map of European Forest Types	0	1	3	0	3	0	3	0
Map of growing stock assessment	0	1	1	0	3	0	3	0
Age structure and/or diameter distribution database	0	1	0	1	3	0	3	0
Map of forest damage	0	1	3	0	3	0	3	0
Maps of tree species composition	0	1	3	0	3	0	3	0
Map of naturalness	0	1	0	1	1	0	1	0
Map deadwood	0	1	0	1	3	0	3	0
Count	0	8	13	3	22	0	22	0

Table 5. Number of datasets provided for the European Data Centre (updated on December 2019).

7.3 Natural and semi-natural habitats
The area of existing natural and semi-natural habitats and their status in the demonstration sites has been stable during the project duration, as foreseen at the beginning of the project. The spatial datasets produced by our

project in each demonstration site with remote sensing technologies provide additional information to forest manager to monitor the impact of climate changes on forest resources.

11.1 Website
The project website was an important tool to reach the general public. At the end of the project the total number of visits of the website was equal to 28000 (Tab 6). We estimated that the num. of unique visits was done by about 5000 individuals, with an average visit duration of about 5 minutes. We estimated that the awareness raising of the general public through the project website was about 2000 individuals.

2015	2017	2018	2019
Num.	Num.	Num.	Num.
812	16747	23000	28000

Table 6. Number of visits of project website (updated on December 2019).

11.2 Other tools for reaching/raising awareness of the general public
This indicator has been quantified taking into account the following data: number of participants to other demonstration events, number of publications, and number of visits of project video (Tab 7-9). At the end of the project, about 700 individuals participated to other demonstration events, 10 publications were published on national and international scientific journal, and about 2500 visits of project video were registered. We estimated that 600 individuals were reached by publications in each specific context, and 300 individuals were awareness raising in each context. The project video were and will be very useful to reach and raising awareness of the general public. The demonstration events were important to explain to the general public the use of remote sensing technologies for forestry applications and raising the awareness of individuals.

2015	2017	2018	2019
Num.	Num.	Num.	Num.
0	181	1614	2500

Table 7. Number of visits of project videos (updated on December 2019).

2015	2017	2018	2019
Num.	Num.	Num.	Num.
0	5	7	10

Table 8. Number of publications (papers/abstracts) (updated on December 2019).

Type of event	2015	2017	2018	2019
	Num.	Num.	Num.	Num.
Demonstration flights	0	260	100	50
Seminars	0	100	300	400
Networking	0	150	200	250
Other demonstration events	0	200	200	300
Count	0	710	800	1000

Table 9. Number of individuals reached by demonstration events (demonstration flights and seminars) and networking (updated on December 2019).

12.1 Networking
The number of individuals reached at the end of the project by networking, seminars, demonstration flights and other demonstration events amounted to about 2500 individuals (Tab. 10, section 6.4). Most of them were not expert on remote sensing technologies. The participation of professionals and students in higher education to these events was great occasion to improve their awareness on the use of new remote sensing technologies for forestry applications.

12.2 Professional training or education
This indicator has been quantified taking into account the number of participants to seminars at the end of the project, which was about 800 participants (Tab 9). The seminars were very useful to train students in higher

education, professionals, members of interest groups, and laymen,

Figure 3. Participants to the training organized from Molise Region during the demonstration flight

13. Jobs
For Job, the num. of expected FTE is confirmed at the end of the project.

14.1 Running cost/operating costs during the project and expected in case of continuation/replication/transfer after the project period
The economic viability considerations carried out in our project to process indicators maps show that, despite the cost of business as usual, i.e. traditional forest inventory in sample plots is lower than the cost of remote sensing derived maps, the final benefits of the two approaches cannot be compared. In fact, in ordinary field work the value of the indicators is known only for a relatively small fraction of the sampling surface, while spatial model derived from remote sensing data allow the spatial estimation of SFM indicators over all the forest surface. In addition, once the remote sensing data have been collected the cost expected in case of continuation after the project period is lower.

14.2.1 Capital expenditure expected in case of continuation/replication/transfer after the project period
To assess this indicator we did an overall estimation of the capital expenditure needed to acquire equipments/tools to be used for setting up the method to be replicated/transferred in the Mediterranean and Continental regions.

14.3 Future funding
To assess this indicator we did an overall estimation of the beneficiaries'own contribution (e.g. University) for setting up the method to be replicated/transferred in the Mediterranea and Continental region.

14.4.3 Entry into new geographic areas
The territories where we expect to replicate/transfer our project are located in Central Italy. In particular, the method used in our project to map the growing stock volume has been already replicated in the Tuscany Region in following territories: a) in the Nature Reserve of Vallombrosa over an area of about 1200 ha; b) along the Tuscan coast to assess the volume in stone pine forests over an area of about 10660 ha.