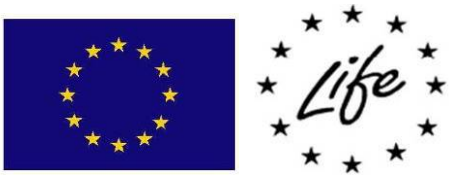

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Further Development and Implementation of an EU-level Forest Monitoring System
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Action C1-HarmonLS-40 (IT)

REVISION OF REPORT A-HARMON LS-10 "DESCRIPTION OF THE NEWLY CREATED SET OF LARGE-SCALE PLOTS"

Gherardo Chirici[1], Piermaria Corona[2], Marco Ferretti[3], Davide Travaglini[1], Lorenzo Fattorini[4], Anna Barbati[2], Francesca Bottalico[1]

[1]Italian Academy of Forest Sciences, Italy
[2]Biofor Italy srl, Italy; University of Tuscia, Italy
[3]TerraData environmetrics srl, Italy
[4] University of Siena, Italy

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Abstract

Data on status and changes of forest condition attributes are requested by the sustainable forest management within the MCPFE (currently Forest Europe) and Montreal processes and for the purposes of forest certification, in both PEFC and FSC schemes. In addition, the potential for climate effects on forests requires timely and reliable evaluations of forest condition.

The project «Further Development and Implementation of an EU-level Forest Monitoring System» (FutMon) aims at the creation of a pan-European forest monitoring system which can serve as a basis for the provision of policy relevant information on forest in the European Union (EU).

In such a context, the Action C1 HarmonLS developed selection criteria for the location of the FutMon large-scale plots (Deliverable 1 - A-HarmonLS-09) taking into consideration the needs of: i) integrating as much as possible existing monitoring schemes; ii) maintaining as much as possible existing time series; iii) creating a large-scale monitoring network representative at European level.

These criteria were used by Associated beneficiaries of FutMon project to select their own plots at national level. The coordinates of the selected plots were used within the Action C1 HarmonLS to create the EU geographical database with the location of the FutMon large-scale plots. For each plot the geographical database was compiled with the following information: i) location; ii) relationship with other existing monitoring schemes (ICP Forests/BIOSOIL, national forest inventories); iii) biogeographical region; iv) forest types following the classification of the European Environment Agency at category level.

In this report, which corresponds to the Deliverable 3 - A-HarmonLS-11, the final description of the newly created set of large-scale plots at national and European level is presented according to the prolongation of FutMon project until June 2011.

1 Introduction

The project «Further Development and Implementation of an EU-level Forest Monitoring System» (FutMon) has started on January 1, 2009, and will end on June 30, 2011.

38 beneficiaries participate at the project, which represents almost all EU-Member States: Austria, Belgium (Flanders), Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, The Netherlands, Poland, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

FutMon aims at the creation of a pan-European forest monitoring system which can serve as a basis for the provision of policy relevant information on forest in the European Union (EU). In short, the objectives of the project are:

- The building of capacities for the coordination of harmonised forest monitoring;
- The collection of quantitative and qualitative forest data;
- The contribution of information needed for sustainable forest management;
- The provision of the network to other project aiming at meeting information needs of the European Commission (EC);
- The analysis of data and the provision of reports on forests.

The project foresees a total of 246 individual actions. In this framework, the Action C1 HarmonLS is under responsibility of the Associated Beneficiary IT 40 – Istituto per lo Studio degli Ecosistemi (ISE) of the Italian Consiglio Nazionale delle Ricerche (CNR). In May 2009 ISE subcontracted this activity to the consortium leaded by the Italian Academy of Forest Sciences (AISF). The consortium's members are: the Academy, Biofor Italy Srl (Italy), TerraData environmetrics Srl (Italy), University of Siena (Italy).

The main role of the Action C1 HarmonLS is the development of selection criteria for the location of the FutMon large-scale plots. Three deliverables are expected by this Action according to the prolongation of FutMon project until June 2011: 1) selection criteria for large-scale plots (Deliverable1 - A-HarmonLS-09); 2) description of the newly created set of large-scale plots (Deliverable2 - A-HarmonLS-10); 3) revision of report A-HarmonLS-10 "description of the newly created set of large scale plots" with data collected by partner beneficiaries in 2010/2011 (Deliverable 3 – A-HarmonLS-11).

It is worth noting that important changes occurred from the original proposal to the operative implementation of the tasks, due to the fact that the original proposal was set up for a time frame of 5 years. ISE subcontracted the activity of the Action C1 HarmonLS to the consortium leaded by AISF one month later than the expected deadline (April 2009) for Deliverable 1. In the meantime, since the beginning of 2009 the Associated beneficiaries initiated their field works selecting plots on the basis of criteria discussed at the meetings held in Florence (March 2009) and Saint Petersburg (May 2009). The draft of the report on Deliverable 1 of Action C1 HarmonLS was presented first in October 2009 and an improved version in November 2009. The final report on Deliverable 1 "Selection criteria for large-scale plots" was illustrated in June 2010 at the 2nd FutMon Status Workshop held in Garmisch-Partenkirchen (Germany).

In December 2009 the Associated beneficiaries completed the selection of plots and in 2010 they had the possibilities to revise their plots on the bases of the criteria developed by Action C1 HarmonLS. The coordinates of the selected plots were used within the Action C1 HarmonLS to create the EU geographical database of the FutMon large-scale plots. For each plot, the following information were included in the database: location, forest type

following the classification of the European Environment Agency, biogeographical region, relationship with other existing monitoring schemes (ICP Forests/BIOSOIL, national forest inventories).

This report relates to the Deliverable 3 (A-HarmonLS-11) of the Action C1 HarmonLS. The report has been structured as follows: in chapter 2 the objectives of the Action and its relationships with other actions are presented; in chapter 3 the key issues for the selection of large-scale plots are recalled; in chapter 4 the description of the large-scale plots at European and national level is presented with reference to: number of plots selected by Associated beneficiaries; relationships between FutMon plots and existing monitoring schemes; distribution of FutMon plots across Biogeographical regions and EFTs; representativeness of selected plots in term of sampling effort required at national level. Discussion and conclusions are reported in chapter 5.

2 Action C1 HarmonLS

2.1 Objectives

The FutMon project aims at the creation of a pan-European forest monitoring system. The reason for the need of a new large-scale forest monitoring grid originate by the fact that there are no monitoring systems able to correctly estimates uncertainty of forest attributes at European level (for further details see Deliverable 1 - A-HarmonLS-09, chapter 4).

In such a perspective, the objectives of the Action C1 HarmonLS are:

1. the development of selection criteria for the location of the FutMon large-scale plots (point locations) that will be the basis of the FutMon large-scale system (Deliverable1 - A-HarmonLS-09);
2. the description of the newly created set of large-scale plots (Deliverable2 - A-HarmonLS-10).

Because plot selection in each Country is under national responsibility, the Action C1 HarmonLS supported this process for Countries involved in Action Group L1: Bulgaria, Denmark, Estonia, Greece, Italy, Romania, Slovenia.

2.2 Relationships with other FutMon actions

2.2.1 Action Group L1

The Action C1 HarmonLS belong to the Action Group L1 “Creation of a large-scale representative monitoring grid”. The objectives of the Action Group L1 are:

- The revision of large-scale monitoring systems aiming at maximising synergies between Level I and National Forest Inventories: the resulting “FutMon large-scale plots” will ideally be a subset of the NFI plots;
- The creation of the basis for future provision of data on core forest variables from coordinated national monitoring systems.

In 2009/2010 all partners revised their current national monitoring systems aiming at maximising synergies between Level I and existing National Forest Inventories (NFIs).

Those Countries that have already been revised their national monitoring systems had only an advisory role in Action Group L1, and submitted the coordinates of their FutMon large-scale plots in the course of the respective Actions L2.

On the contrary, those Countries that needed to revise their national monitoring grids carried out the Action L1. Countries participated in an Expert Meeting where transnationally relevant guidelines were elaborated. The Action C1 HarmonLS supported this process of plots selection. At the end of the Actions L1, FutMon large-scale plots were selected in each country and their coordinates were submitted to the Coordinating Beneficiary.

In this work, countries started from different positions depending on their history of conducting NFIs and Level I inventory under Forest Focus and previous EU Regulations. Those countries that already revised their national monitoring grids – with regard to Level I and NFIs – did not need to participate, although their solutions served as examples to the countries undertaking the Action L1.

Results expected from the Action Group L1 are: 1) descriptions of country level solutions to the set-up of national monitoring systems and 2) coordinates of plots constituting the FutMon large-scale grid.

2.2.2 Action Group L2

The Action Group L2 “Large-scale representative monitoring” is related to Action Group L1 and, as such, to the Action C1 HarmonLS. This action includes field assessments on FutMon large-scale plots aiming at the continuation of existing time series for forest condition. In addition, this action provides data to support the further harmonisation of NFIs, through developing reference methods and bridging functions.

The Action Group L2 is divided into two sub-groups with different aims:

- L2a) Large-scale assessments is carried out, either on old Level I or on new FutMon plots in 2009 and 2010. Monitoring include annual assessments of mandatory parameters foreseen for large-scale monitoring in the ICP Forests manual;
- L2b) NFI field studies is conducted in order to (i) test reference assessment methods and (ii) develop test and enhance bridging functions for a set of core variables.

The L2b activities is build upon the experience reached in the COST Action E43 and other projects on further harmonisation of National Forest Inventories in Europe: the aim is to improve bridge functions for common reporting.

The Action L2 is joined by C1-NFI-8(DK) and C1-NFI-25(SE) which support the NFI-based analyses through elaboration of methods in collaboration with the partners and compilation of summary results.

In particular, the action C1-NFI-8(DK) includes coordination of experts from NFIs aiming at the harmonisation of NFIs. In such a context existing bridging functions for core variables are reviewed. The further development of the bridging functions are made in close collaboration with the Action C1-NFI-25(SE).

The involved experts have evaluated the needs for field studies based on the results of evaluations by the action C1-NFI-25(SE). The action contributes to the coordination of the field study under Action Group “L2(b)” and provides a forum for discussion and for continuous evaluation of the progress in the field studies.

The demonstration field study are conducted under Action Group “L2”. Selection of plots is under national responsibility.

2.3 Meetings

The kick off meeting of the Action C1 HarmonLS with also the participation from Action C1-NFI (DK) and Action C1-NFI (SE) took place from 19th to 20th March 2009 in Florence (Italy). The meeting was organized to exchange information in order to create a comprehensive pan-European overview of the mutual relationships between different large-scale forest monitoring networks in the different countries with a special focus on ICP Forests Level I and NFIs plots. Country report with information on present and future actions finalized to integrate NFI and ICP Forests networks were presented and discussed. The meeting closed with some general conclusions.

At the 1st FutMon Status Workshop held in Saint Petersburg in May 2009, the basic principles for the selection of large-scale plots developed by Action C1 HarmonLS were presented to the Associated Beneficiaries.

The 2nd meeting of the Action C1 HarmonLS was in Copenhagen (Denmark) in November 2009. The meeting was back-to-back co-organised with Action C1-NFI (DK) and Action C1-NFI (SE). The meeting aimed at updating the status of the actions, the steps needed to be carried out in 2010 and to agree upon some relevant issues. In this meeting it was remembered that L1 plots are part of the large-scale grid, but the complete large-scale grid should incorporate a larger number of plots. The minimum number of L1 plots for each country is equal to the forest area in km^2 divided by 256, equivalent to a systematic grid of 16 x 16 km according to the project proposal. In addition, the improved basic principles for the selection of L1 plots developed by Action C1 HarmonLS and reported in the inception report were presented. The basic principles were agreed during the meeting. The meeting closed with the steps needed for the development of the action:

- Definition of the L1 plots by the countries and submission of coordinates and metainformation to the coordinator of the FutMon project;
- The C1 HarmonLS team will create a first proposal of the large-scale and will communicate to the countries those actions needed for locally adjusting the large-scale grid.

The action will develop also the statistical estimators needed to aggregate the estimations based on different grids at country level to provide a unique European statistically formally estimations for mean defoliation, proportion of trees with defoliation higher than 25% and their annual changes.

The 2nd FutMon Status Workshop was the 1-2 June 2010 in Garmisch-Partenkirchen (Germany). The meeting was held back to back with 26th Task Force Meeting of ICP Forests. In the course of the meeting the final version of the Selection criteria for large-scale plots developed by Action C1 HarmonLS were presented and discussed. In particular, the following results obtained by the Action were presented: results of the questionnaires circulated in March 2009 and May 2010; status of integration between ICP Forest Level I and NFI networks; EU statistical estimator; criteria for the selection of FutMon large-scale forest monitoring plots; strategies for harmonizing NFI and Forest Condition Monitoring (FCM) networks.

The L2 Coordination meeting FutMon and NFI was in Copenhagen the 22 June 2010. During the meeting the selection criteria for the location of FutMon large-scale monitoring plots were presented to the participating Countries focusing on how utilize synergies between ICP level I and NFI plots. After the presentation, a thorough discussion about different topics related to the linkages between NFIs and ICP level I followed.

On 1-2 December 2010 the results of Action C1 HarmonLS were presented to the LIFE-Unit during the FutMon meeting which took place in Hamburg (Germany).

In addition, the results produced by Action C1 HarmonLS were presented at the FutMon Final Workshop which took place the 21st June 2011 in Brussels (Belgium).

3 Selection of FutMon large-scale plots

The basic principles for the selection of FutMon plots developed by Action C1 HarmonLS were presented and discussed at the following meetings: in Florence at the ICP Forests/FutMon Expert Meeting (March 2009), in Saint Petersburg at the 1st FutMon Status Workshop (May 2009), in Copenhagen at the 2nd Meeting of the Action C1 HarmonLS (November 2009). According to these principles, the original ICP Forests Level I grid was revised by participating Countries so that as many FutMon plots as possible coincide with NFI plots.

Plot selection was completed by countries in December 2009 and revised in 2010. The coordinates of each plot were submitted to the Coordinating Beneficiary by each Country. The location of the plots was then transmitted by Coordinator to the responsible of the Action C1 HarmonLS. This data was used within the Action C1 HarmonLS to improve the development of selection criteria and complete the Deliverable1 - A-HarmonLS-09 “Selection criteria for large-scale plots”.

The contents of the report A-HarmonLS-09, which include the following main issues, were presented in Garmisch-Partenkirchen (Germany) at the 2nd FutMon Status Workshop (June 2010):

- Results of the questionnaires circulated by Action C1 HarmonLS in March 2009 and May 2010;
- Status of integration between ICP Forest Level I and NFI networks;
- Construction of a large scale forest monitoring grid in Europe;
- EU statistical estimator for the assessment of the parameters of concern and their changes between years;
- Strategies for harmonizing NFI and FCM networks.
- Criteria for the selection of FutMon large-scale forest monitoring plots;

• The construction of a large scale forest monitoring grid in Europe is a proposal which aims at producing forest condition assessment at European scale by using country level estimates. The procedure is based on the assumption that the same definition of forest holds among all European countries. Under this assumption a formal definition of monitoring objectives, parameters of concern and accuracy standards for assessing their status and changes has been suggested for the first time. The proposal adopts a probabilistic sampling scheme: the assessment of the forest condition parameters is based on fixed-area plots thrown onto to the target region by means of systematic or stratified schemes. Statistical estimators have been developed to produce forest condition parameters estimation at country and at European levels. Estimations at European level are based on two alternative strategies: the combination of FCM estimates or the aggregation from FCM and NFI estimates. The proposed statistical strategies for European level forest condition assessment based on independent country estimates is shown in Diagram 1.

Guidelines and practical suggestions towards an harmonized system between FCM and NFI networks have been drawn for the following cases (Ferretti, 2010): a) FCM and NFI are already on the same network; b) FCM and NFI are carried out on separate networks. In the former case harmonization exists at national level even if some further harmonization may be necessary to adapt national definitions to international one using bridging functions. In the latter case, three scenarios have been proposed to get

integration between networks: 1) Harmonization of methods; 2) Functional integration of networks; 3) Full integration of networks (Table 1).

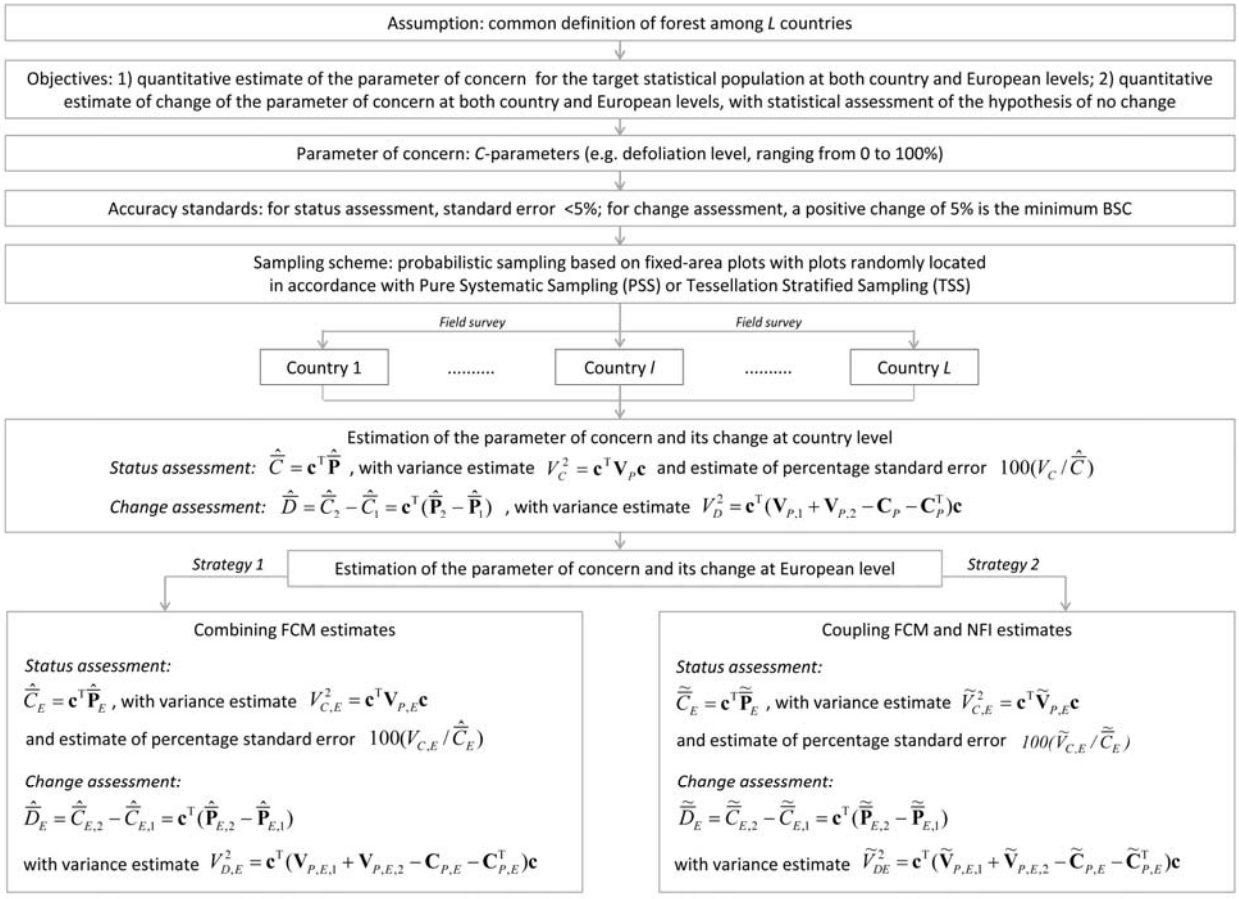


Diagram 1. Statistical strategies for European level forest condition assessment based on independent country estimates.

The key issues developed within the Action C1 HarmonLS for the selection of large-scale plots are here summarized (for further details refers to the project report “The FutMon large-scale forest monitoring grid” by Chirici et al. 2010):

1. An important pre-requisite is that the statistical (target) population is the same across Europe, as the use of a different target population among countries preclude the achievement of estimates at European level. This imply that in case of integration between Level I and NFI networks the statistical population must be the same.
2. The original plots selection should have been done on a probabilistic basis. Assuming this was true for both Level I and NFI networks, Countries should make proper decision according to the following strategies for harmonizing NFI and FCM networks: a) Harmonization of methods; b) Functional integration of networks; c) Full integration of networks (Table 1).
   a) Harmonization of methods implies the adoption of similar protocols for assessment/measurements by FCM and NFI, while networks may stay separated and plots may keep their own characteristics; it represents the simplest and less expensive solution to get harmonized dataset maintaining existing data series.

b) With the functional integration of networks, FCM and NFI networks remain separated but they will use not only the same attributes and methods as in the former scenario, but also the same plot design, which implies consistency in tree selection criteria; under this scenario FCM plots may adopt the design used by NFIs, while keeping the assessment also on trees that were previously considered in order to maintain existing data series; assessment will be done on both FCM and NFI networks, although not necessarily with the same time frequency; this implies some work to be done to adapt the plots, but – under the assumption of a common target population – results can be used jointly to derive more accurate estimates.
c) Full integration of networks (all-in-one) foresees that the original FCM plots will be ceased and FCM attributes will be measured only on NFI plots (the other way round is less likely) to obtain a single, fully integrated and harmonized set of data; it is worth noting that under this scenario the FCM data series will be lost both at country and European level (for further details, see Ferretti, 2010).
Whatever the decision made, emphasis is placed on the importance of preserving as much as possible existing data series on forest condition.

3. The selection of a fixed number of nearest trees around sites precludes the use design-based estimation at country level on the current Level I network (nearest neighbor selection needs for assumptions about the distribution of trees over the study area). To overcome this problem plots should have a known area. Should it be not the case, statistical estimates are not possible within a p-based inferential process, and all the reasoning about the number of plots is not applicable. It is not necessary that plots will have the same area across Europe, but it is necessary they will have the same area within individual countries.
4. The number of plots should be decided at country level taking into account the desired level of precision of estimates, in relation to the desired level of detection (e.g., extent of proportion of defoliated trees the survey wishes to detect at the stated level of uncertainty) and change detection.
5. •When a minimum number of plots is necessary, reference is made to the nominal density adopted on Level I plots, i.e. one plot every 256 km2; however, this density may be not appropriate for small countries and/or low frequency of defoliated trees, and/or individual species as shown in Table 1a, where the sampling efforts (in terms of number of sites and number of selected trees) necessary to achieve a percentage standard error of 5% are reported for each European country; as these efforts are determined presuming a rough with-replacement random selection of trees from the population, which should be less accurate than the systematic grids of plots adopted in most European country, the reported efforts are highly cautionary and likely provide standard errors smaller than 5%.

Harmonization process	Monitoring networks	Plot design	Attribute and assessment methods	Advantages	Disadvantages
1. Harmonization of methods	FCM and NFI networks stay separated	FCM and NFI plots maintain their own characteristics	FCM attributes and assessment methods are adopted by NFI. Assessment will be done on both FCM and NFI	Harmonized datasets in terms of attributes and measurements. Maintenance of existing data series	Limited. Little work is necessary
2. Functional integration of networks	FCM and NFI networks stay separated	FCM adopts the NFI plot design. The assessment on trees that were previously considered by FCM is maintained	FCM attributes and assessment methods are adopted by NFI. Assessment will be done on both FCM and NFI	Harmonized datasets. Maintenance of existing data series. Combined estimates may be possible	Slight increase of costs
3. Full integration of networks (all-in-one)	FCM network is closed and moved to NFI one	Original FCM plots is ceased	FCM attributes are measured only on NFI plots	A single, fully integrated and harmonized dataset is obtained	FCM data series is lost at country and European level

Table 1. Harmonisation processes between Forest Condition Monitoring (FCM) and National Forest Inventory (NFI) networks (from Ferretti, 2010).

Table 1a. Sampling effort of ICP Forests network in term of plots (R) and trees (T) performed in 2008 surveys compared with sampling effort ($R_{0.05}$, $T_{0.05}$) required for estimating the proportion of defoliated trees greater than 25% ($\hat{F}_{25}$) with a percentage standard error of 5%. Sampling effort in terms of trees is achieved presuming a with-replacement selection of trees from the population. Sampling effort in terns of plots is derived dividing the number of trees to the average number of trees per plots (T/R) observed in 2008 surveys. (Asterisks denote countries performing insufficient sampling). Data for the following countries participating at the Action C1-HarmonLS were not available: Greece, Romania.

Country	R	T	T / R	$\hat{F}_{25}$	$T_{0.05}$	$R_{0.05}$
Andorra*	3	72	24.00	15.3%	2215	92
Belarus	400	9460	23.65	8%	4600	195
Belgium	121	2860	23.64	14.5%	2359	100
Bulgaria	136	4531	33.32	31.9%	854	24
Croatia	85	2039	23.99	23.9%	1273	53
Cyprus*	15	360	24.00	46.9%	452	19
Czech Rep.	136	5477	40.27	56.7%	306	8
Denmark*	19	452	23.79	9.1%	3996	168
Estonia*	92	2196	23.87	9%	4045	170
Finland	475	8819	18.57	10.2%	3522	190
France	508	10138	19.96	32.4%	835	42
Germany	423	10347	24.46	25.7%	1157	43
Ireland*	31	679	21.90	10%	3600	165
Italy	236	6579	27.88	32.8%	820	30
Latvia	342	8090	23.65	15.3%	2215	94
Lithuania	1342	7539	5.62	19.6%	1641	292
Rep. Moldova	528	9841	18.64	33.6%	791	43
Norway	1720	9495	5.52	22.7%	1363	247
Poland	1916	39320	20.52	18%	1823	89
Serbia*	130	2789	21.45	11.5%	3079	144
Slovak Rep.	108	4083	37.81	29.3%	966	26
Slovenia	44	1056	24.00	37%	742	31
Spain	620	14880	24.00	15.6%	2165	90
Sweden	3464	6890	1.99	17.3%	1913	961
Switzerland*	48	1008	21.00	19%	1706	82
Turkey	398	8978	22.56	24.6%	1227	55
Ukraine	1465	33986	23.20	8.2%	4479	194

4 The FutMon large-scale monitoring grid

4.1 The EU geographical database

The coordinates of plots selected by Associated beneficiaries were used by Action C1 HarmonLS to create the EU geographical database with the location of the "FutMon large-scale plots".

The coordinates of the plots received from Coordinating beneficiary were crosscheck with information on plots location provided by Countries through the questionnaire which was circulated in May 2010 by Action C1 HarmonLS. After the check all coordinates were projected in the ETRS89 LAEA projection system and the geographical database with the location of the FutMon large-scale plots was created by using the ESRI shape file format.

The geographical database of the FutMon large-scale monitoring grid was then compiled for each FutMon plot with the following fields:

a) *Plot status:* this field was compiled using information provided by Coordinating beneficiary; the field indicates if the plot has been submitted by Country for the first time (new FutMon plot) or if it is already existing as ICP Forest plot;

b) *Relationship between FutMon plot and NFI plot:* this field was compiled using information received both from Countries through the questionnaires and from Coordinator. The field can has the following values:

   1. FutMon plot with NFI assessments: it means that NFI data are assessed on corresponding FutMon plot;
   2. FutMon plot without NFI assessments: it means that NFI data are not assessed on corresponding FutMon plot;
   3. FutMon plot unknown if having NFI assessments: it means that for the corresponding Country part of the FutMon plot provide NFI data but it's not known which one;
   4. Missing data: this means that the corresponding Country didn't send information on the relationship between FutMon plots and NFI plots;

c) *Relationship between FutMon plot and Biosoil plot:* this field was compiled using information received from Countries through the questionnaires. The field can has the following values:

   1. FutMon plot with Biosoil assessments: it means that Biosoil data are assessed on corresponding FutMon plot;
   2. FutMon plot without Biosoil assessments: it means that Biosoil data are not assessed on corresponding FutMon plot;
   3. FutMon plot unknown if having Biosoil assessments: it means that for the corresponding Country part of the FutMon plot provide Biosoil data but it's not known which one;
   4. Missing data: this means that the corresponding Country didn't send information on the relationship between FutMon plot and Biosoil plot;

d) *Biogeographical region*: each FutMon plot was classified in to the following biogeographical region: Alpine; Atlantic; Black sea; Boreal; Continental; Macaronesia; Mediterranean; Pannonian; Steppic;

e) European Forest Type (category level): each FutMon plot was classified in to one of the 14 categories of the EFT, see Table 2 (EEA, updated vers. June 2010).

Table 2. European Forest Types, category level (updated version June 2010).

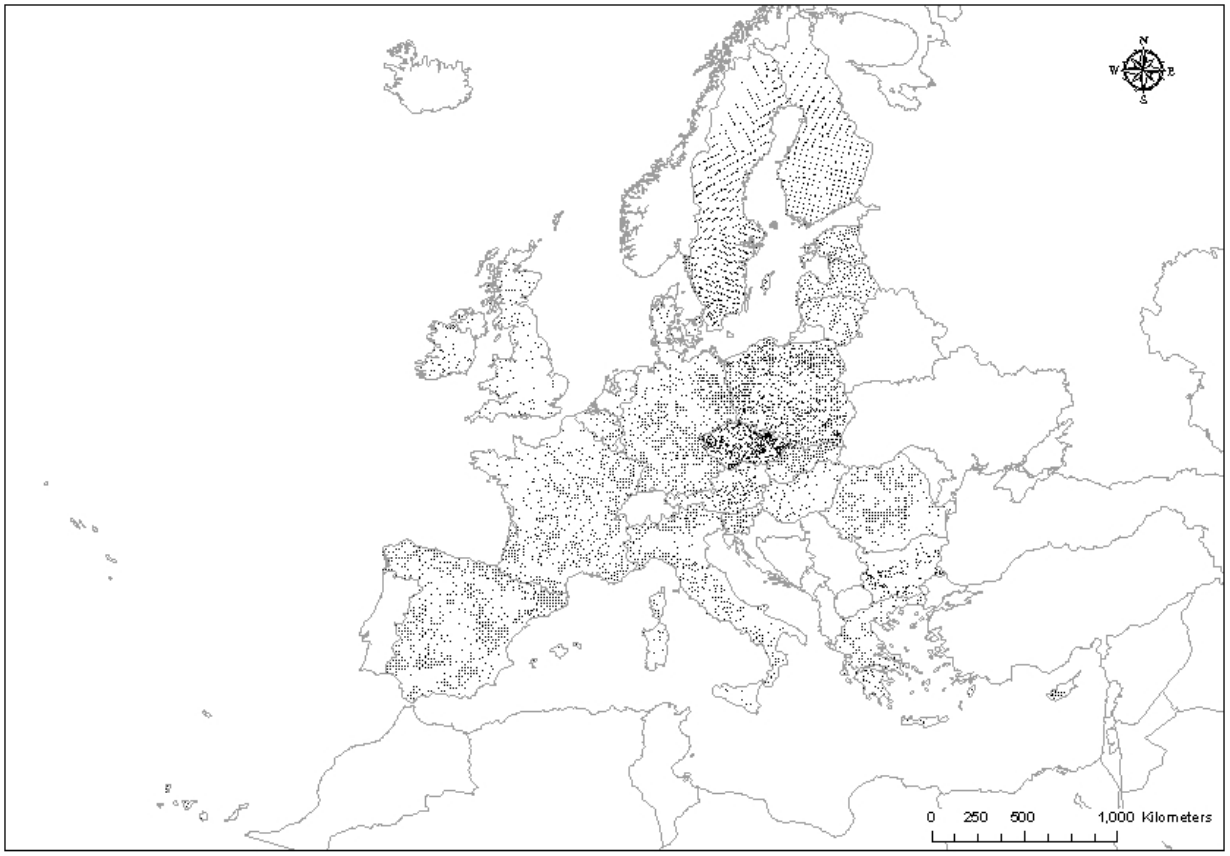
EFTs – Category level	*Main characteristics*
1. Boreal forest	Extensive boreal, species-poor forests, dominated by *Picea abies* and *Pinus sylvestris*. Deciduous trees including birches (*Betula* spp.), aspen(*Populus tremula*), rowan (*Sorbus aucuparia*) and willows (*Salix* spp.) tend to occur as early colonisers.
2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest	Latitudinal mixed forests located in between the boreal and nemoral (or temperate) forest zones with similar characteristics to cat. 1, but a slightly higher tree species diversity, including also temperate deciduous trees like *Tilia cordata*, *Fraxinus excelsior*, *Ulmus glabra* and *Quercus robur*. Includes also: pure and mixed forests in the nemoral forest zone dominated by coniferous species native within the borders of individual MCPFE member states like *Pinus sylvestris,* pines of the *Pinus nigra* group*, Pinus pinaster*, *Picea abies, Abies alba*.
3. Alpine forest	High-altitude forest belts of central and southern European mountain ranges, covered by *Picea abies*, *Abies alba, Pinus sylvestris, Pinus nigra, Larix decidua, Pinus cembra* and *Pinus mugo*. Includes also the mountain forest dominated by birch of the boreal region.
4. Acidophilous oak and oak-birch forest	Scattered occurrence associated to less fertile soils of the nemoral forest zone; the tree species composition is poor and dominated by acidophilous oaks (*Q. robur, Q. petraea*) and birch (*Betula pendula*).
5. Mesophytic deciduous forest	Related to medium rich soils of the nemoral forest zone; forest composition is mixed and made up of a relatively large number of broadleaved deciduous trees: *Carpinus betulus, Quercus petraea, Quercus robur, Fraxinus, Acer* and *Tilia cordata*.
6. Beech forest	Widely distributed lowland to submountainous beech forest. Beech, *Fagus sylvatica* and *F. orientalis* (Balkan) dominate, locally important is *Betula pendula*.
7. Mountainous beech forest	Mixed broadleaved deciduous and coniferous vegetation belt in the main European mountain ranges. Species composition differs from cat. 6, including *Picea abies*, *Abies alba*, *Betula pendula* and mesophytic deciduous tree species. Includes also mountain fir dominated stands.
8. Thermophilous deciduous forest	Deciduous and semi-deciduous forests mainly of the Mediterranean region dominated by thermophilous species, mainly of *Quercus*; *Acer*, *Ostrya*, *Fraxinus*, *Carpinus* species are frequent as associated secondary trees. Includes also *Castanea sativa* dominated forest.
9. Broadleaved evergreen forest	Broadleaved evergreen forests of the Mediterranean and Macaronesian regions dominated by sclerophyllous or lauriphyllous trees, mainly *Quercus* species.
10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions	Varied group of coniferous forests in Mediterranean, Anatolian and Macaronesian regions, from the coast to high mountains. Dry and often poorly-developed soils limit tree growth. Several tree species, including a number of endemics, of *Pinus, Abies* and *Juniperus* species.
11. Mire and swamp forest	Wetland forests on peaty soils widely distributed in the boreal region. Water and nutrient regime determines the dominant tree species: *Pinus sylvestris, Picea abies* or *Alnus glutinosa.*
12. Floodplain forest	Riparian and riverine species-rich forests characterised by different assemblages of species of *Alnus, Betula, Populus, Salix, Fraxinus, Ulmus*.
13. Non-riverine alder, birch or aspen forest	Pioneer forests dominated by *Alnus, Betula* or *Populus*.
14. Introduced tree species forest	Forest dominated by introduced tree species. Occur on a wide range of site conditions which otherwise would develop forests of above categories. Introduced tree species can be identified at regional (recommended) or national level and comprise: - tree species that are not native to Europe (e.g. *Eucalyptus* spp., *Robinia pseudoacacia*, *Acacia dealbata*, *Ailanthus altissima, Prunus serotina, Quercus rubra, Fraxinus alba, Picea sitkensis*, *Pinus contorta*, *Pinus banksiana, Pseudotsuga menziesii*, *Tsuga heterophylla*); - tree species native to Europe, but not naturally occurring within the borders of individual Forest Europe member state; - tree species native only in some regions of an individual Forest Europe country.

4.2 Description of the FutMon large-scale monitoring grid

A total number of 6941 plots were selected by Associated beneficiaries. More than 82% of the total number of the selected plots already exists as ICP Forest Level I plot while the remaining plots were selected for the first time as new FutMon plots.

The location of the newly set of large-scale plots created under FutMon project is presented in Figure 1.

Figure 1. Location of the FutMon large-scale plot.



According to the selection criteria developed by Action C1 HarmonLS, the original ICP Forests Level I grid was revised so that as many FutMon plots as possible coincide with existing monitoring scheme. The spatial relationships between the FutMon large-scale plots, the NFI plots and the Biosoil plots are presented in Figures 2 and 3: 4021 FutMon plots (58%) coincide with NFI plots (Figure 4) denoting a good level of integration between EU and national monitoring networks; 1752 FutMon plots (25%) currently coincide with Biosoil plots (Figure 5).

The distribution of the FutMon plots over the biogeographical regions is presented in Figure 6: more than 66% of the total number of FutMon plots are located in the Continental (38.5%) and Boreal (27.6%) regions; more than 31% of the plots are positioned in the Mediterranean (13.5%), Alpine (10.2%) and Atlantic (7.8%) regions; the remaining plots (less than 3%) fall in the Black sea, Macaronesia, Pannonian and Steppic regions (Figure 7).

The distribution of the FutMon plots labeled on the bases of the 14 EFT at category level is presented in Figure 8. The frequency (%) of FutMon plot in each category is presented in Figure 9.

A detailed description at country level of FutMon monitoring network is reported in chapter 4.3.

Figure 2. Relationship between FutMon and NFI plot.

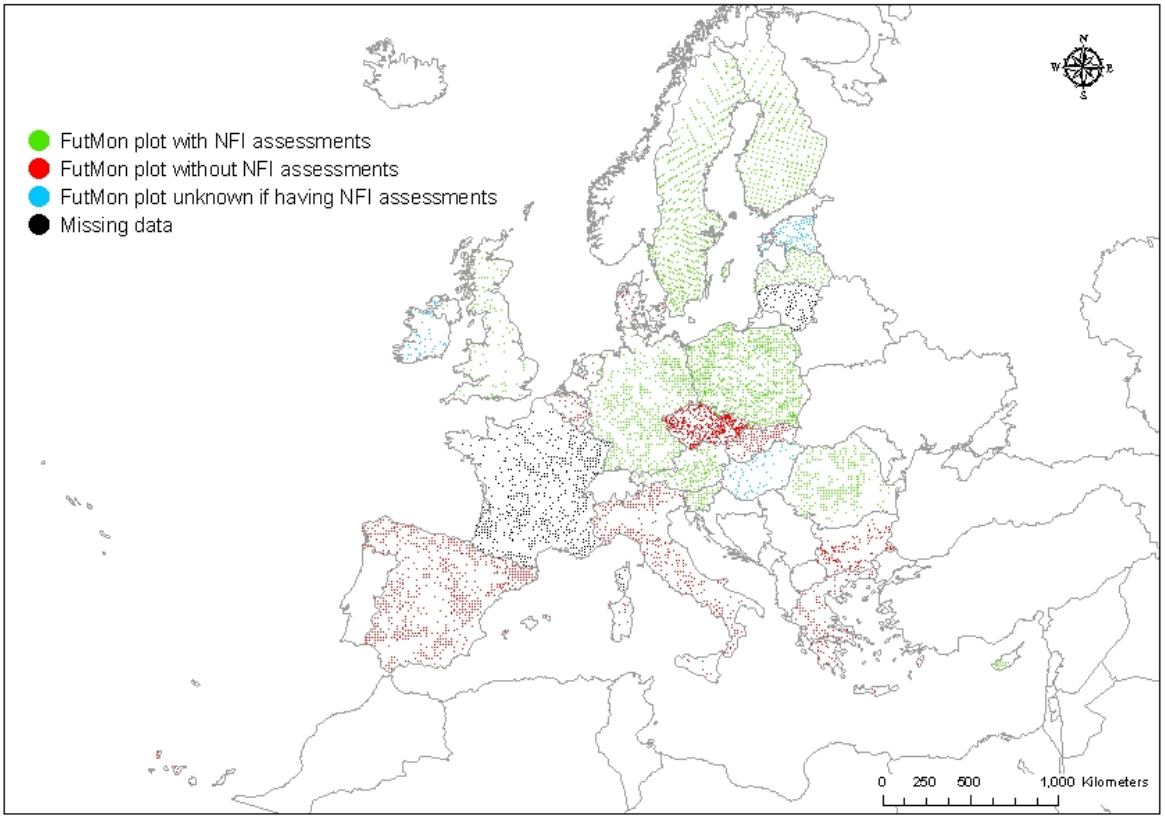


Figure 3. Relationship between FutMon and Biosoil plot.

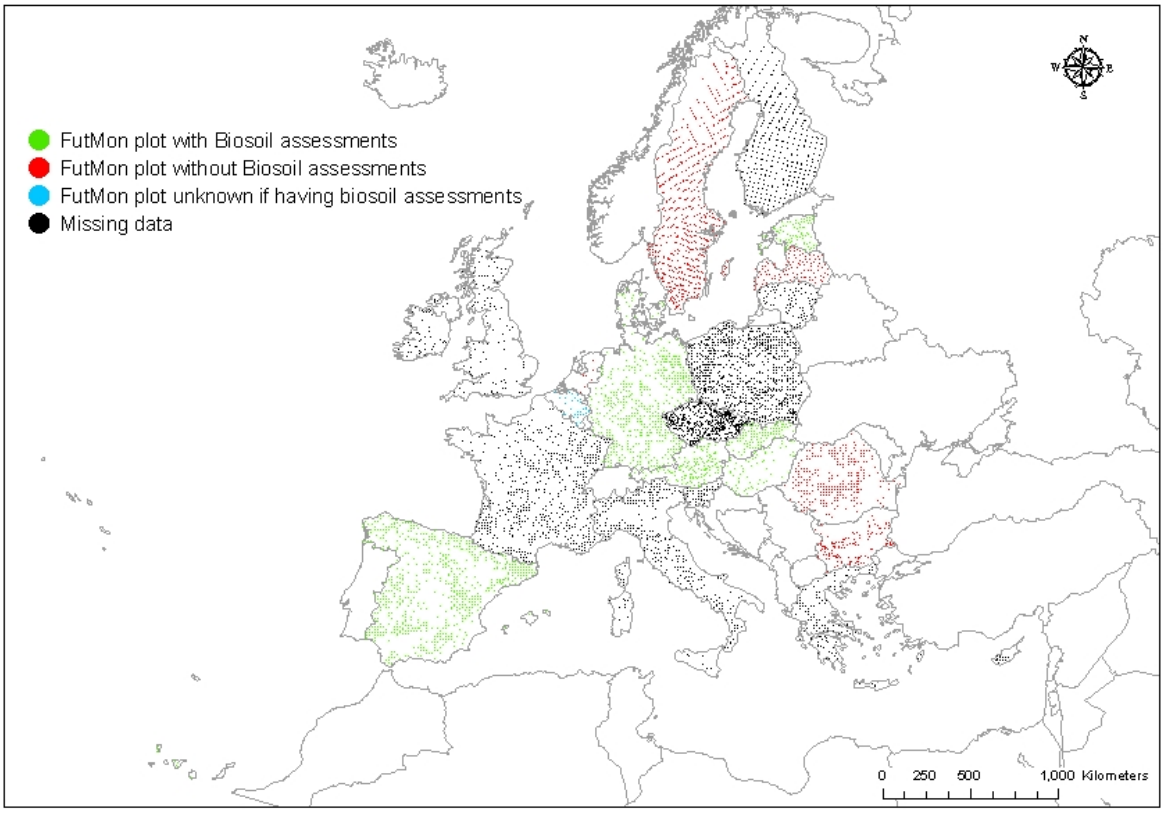


Figure 4. Frequency (%) of FutMon plot with or without NFI assessments

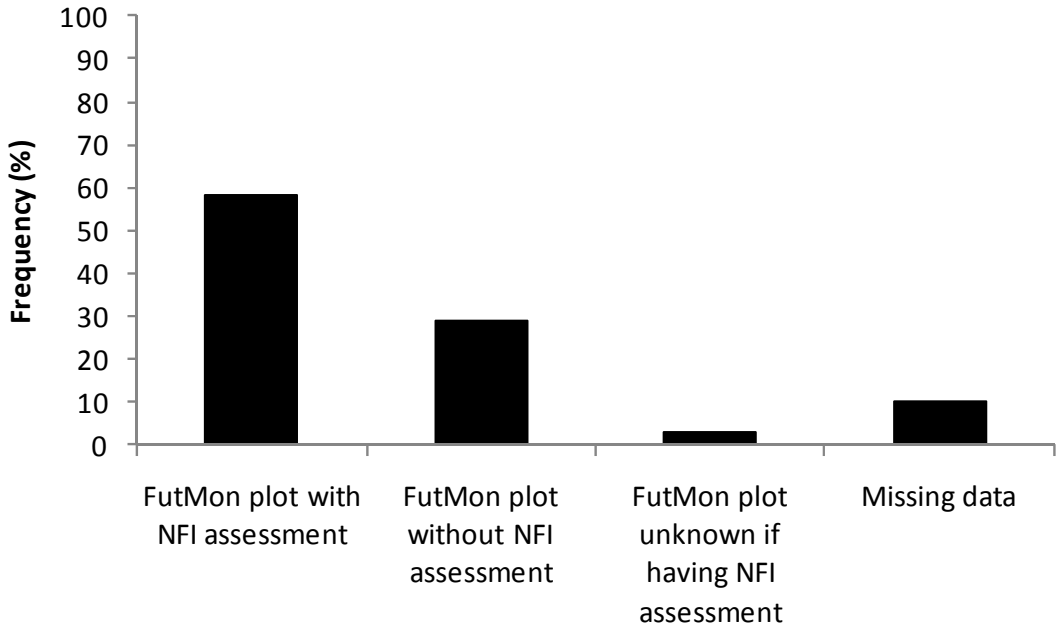


Figure 5. Frequency (%) of FutMon plot with or without Biosoil assessments.

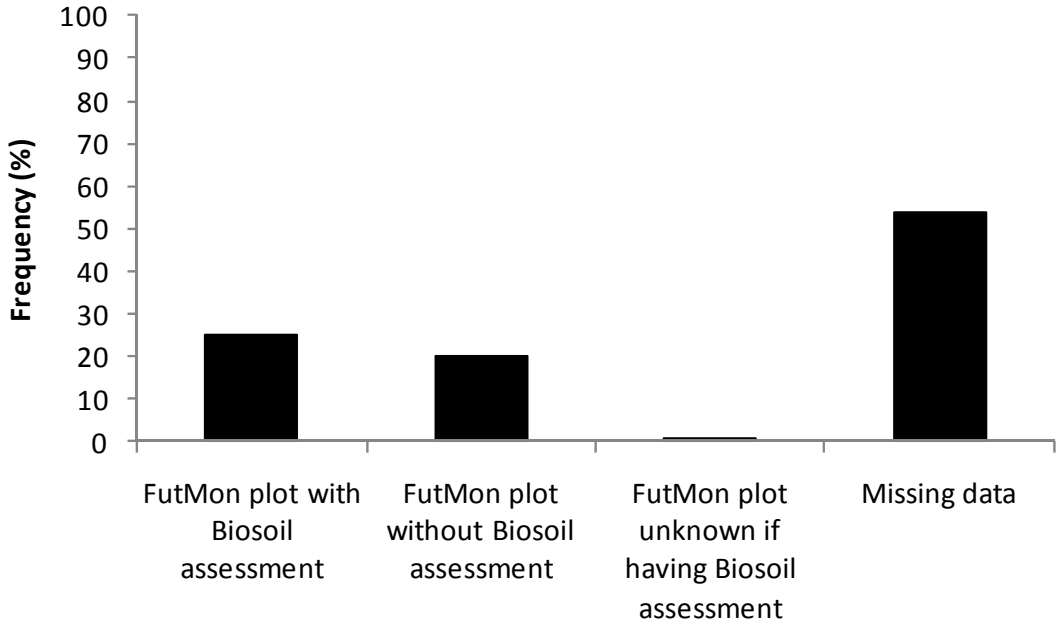


Figure 6. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

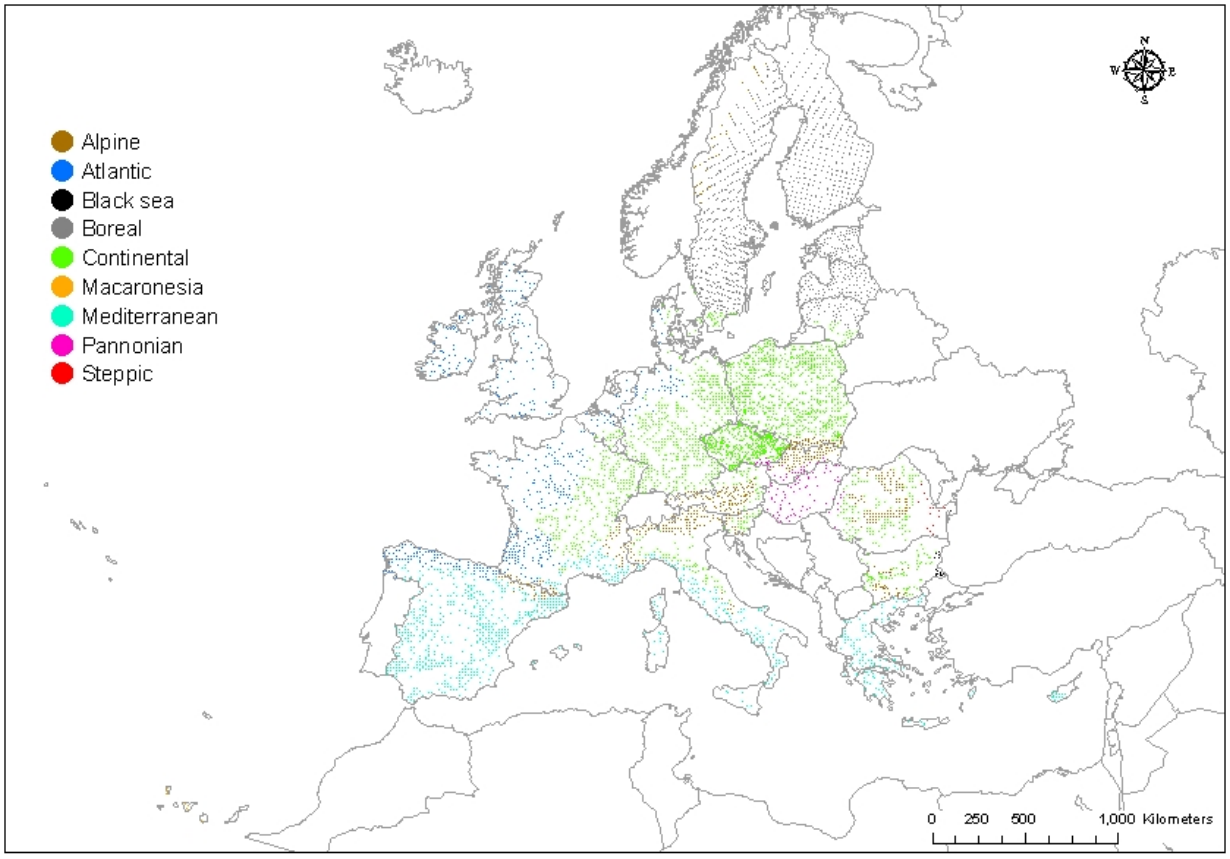


Figure 7. Frequency (%) of FutMon plot in each Biogeographical region.

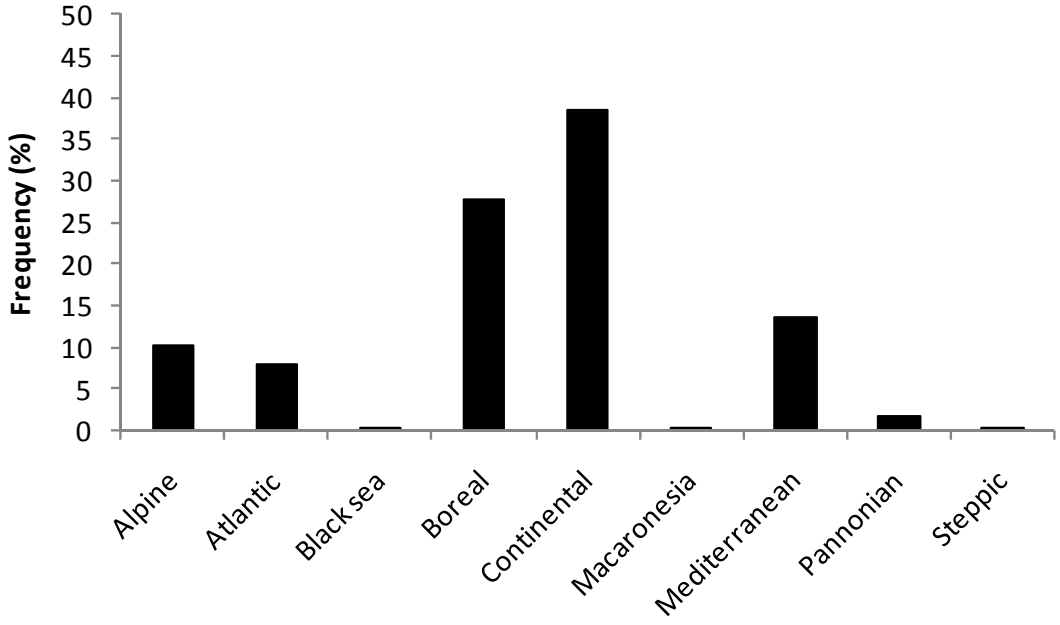


Figure8. FutMon large-scale plot labeled with different colors representing the EFT at category level (see Table 2).

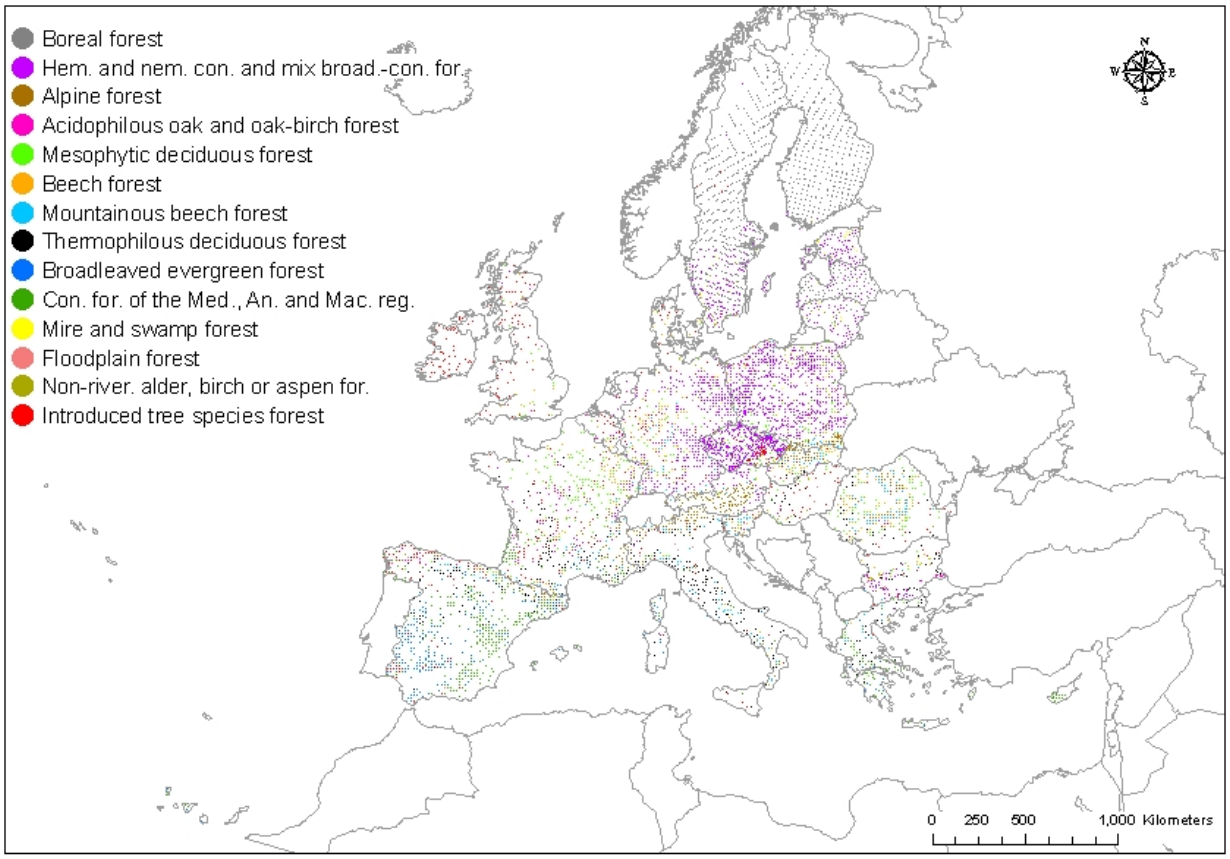
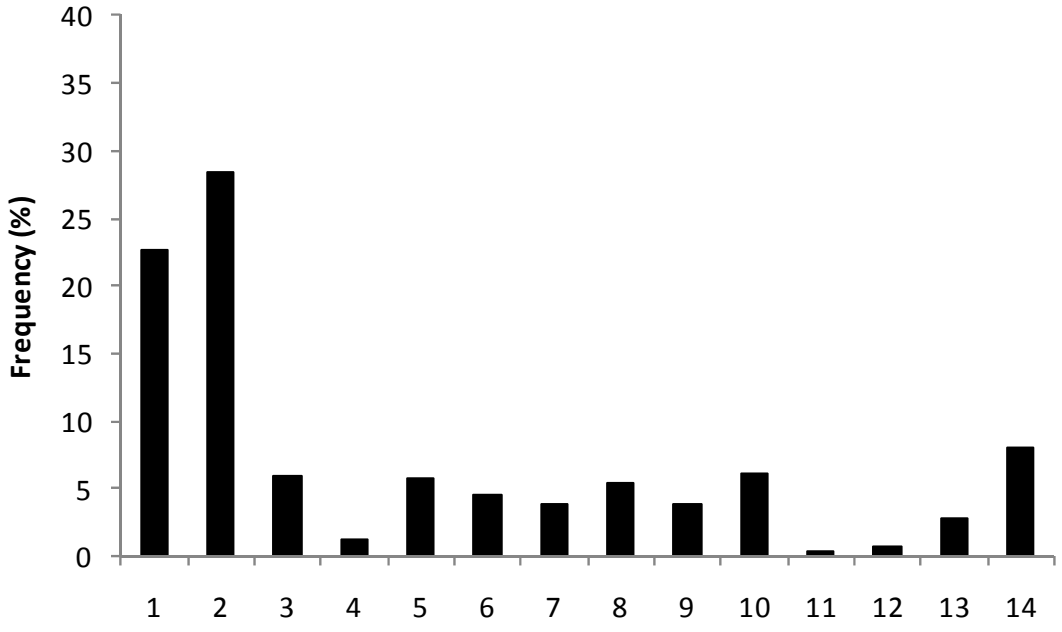


Figure 9. Frequency (%) of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).



4.3 Description of the FutMon grid at national level

4.3.1 Austria

Total number of FutMon large-scale plots: 140 (Figure 10).

Relationships with existing monitoring networks: full integration between FutMon, ICP, NFI and Biosoil plots (ICP Level I and Level II is a subsample of NFI).

Biogeographical regions: more than 70% of plots are located in Alpine Regions; the remaining plots are in the Continental Regions (Table 3, Figure 11).

Forest types at category level (EEA): the most part of plots are located in the following categories: Alpine forest (66%); Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest(23%) (Table 4, Figure 12).

Figure 10. Distribution of FutMon plots over forest-non forest map.

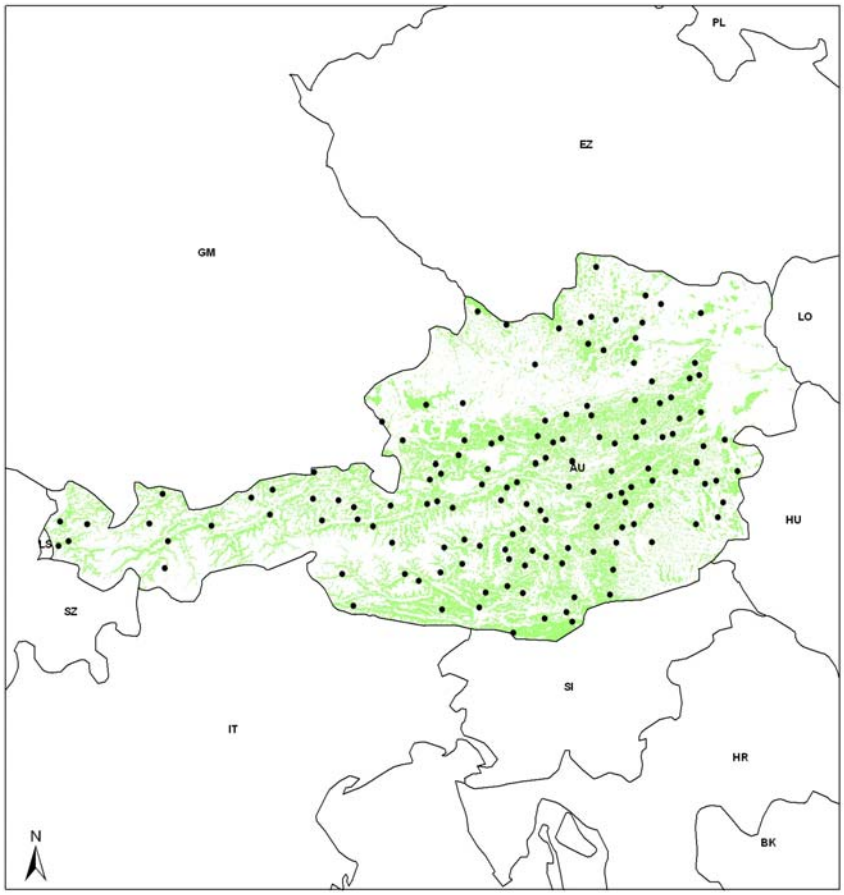


Table 3. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Austria	100	0	0	0	40	0	0	0	0	140

Table 4. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Austria	0	32	93	0	4	2	8	0	0	0	0	1	0	0	140

Figure 11. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

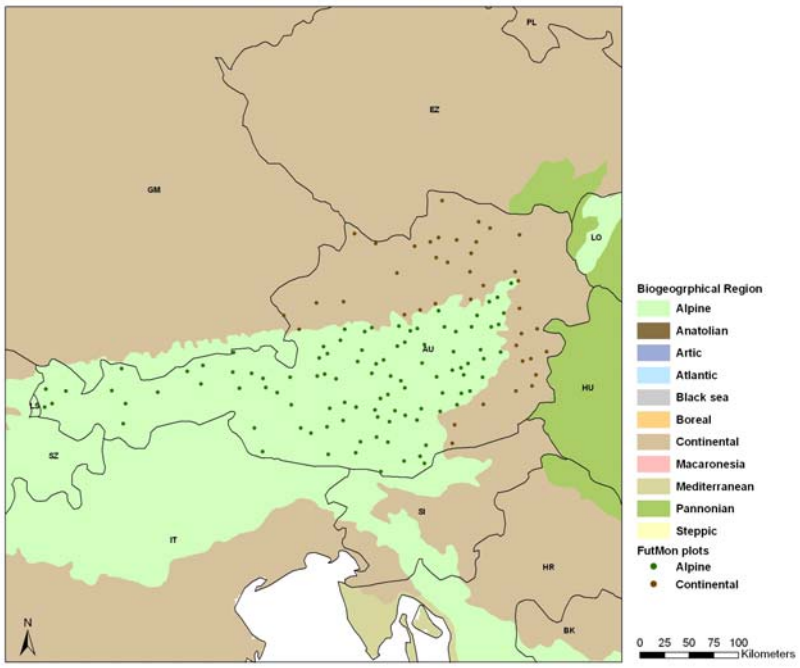
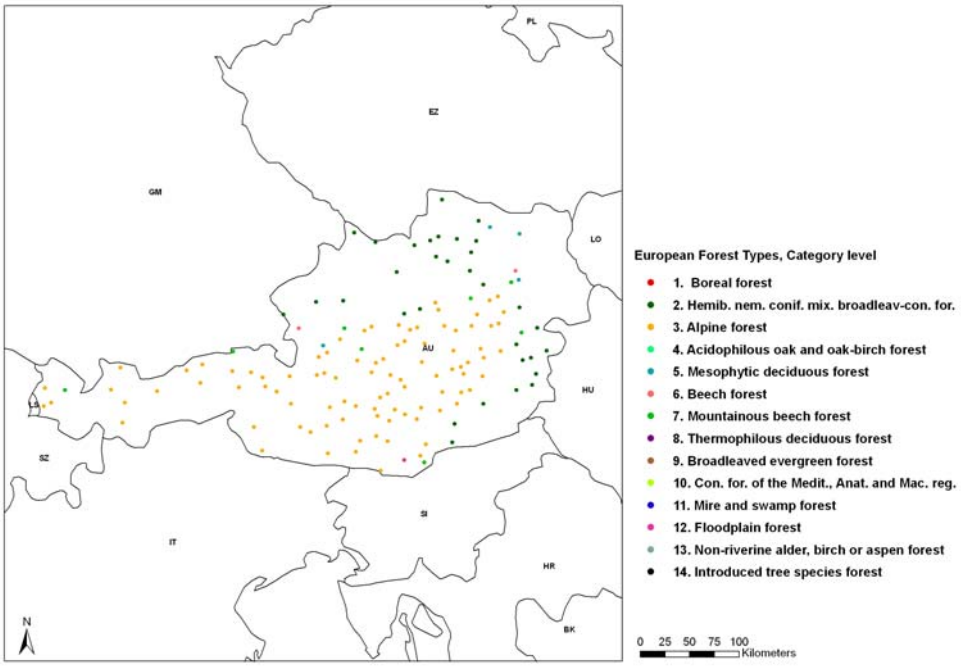


Figure 12. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.2 Belgium

Total number of FutMon large-scale plots: 33 (Figure 13).

Relationships with existing monitoring networks: full integration between FutMon and ICP Level I plots; no relationship between FutMon and NFI plots; part of FutMon plots coincide with Biosoil plots.

Biogeographical regions: 64% of plots are located in the Continental region; 36% of plots are in Alpine region (Table 5, Figure 14).

Forest types at category level (EEA): the most part of plots are located in the following categories: Introduced tree species forest (45%); Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest (15%); Beech forest (15%) (Table 6, Figure 15).

Representativity: the total number of FutMon large-scale plots is less than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 13. Distribution of FutMon plots over forest-non forest map.

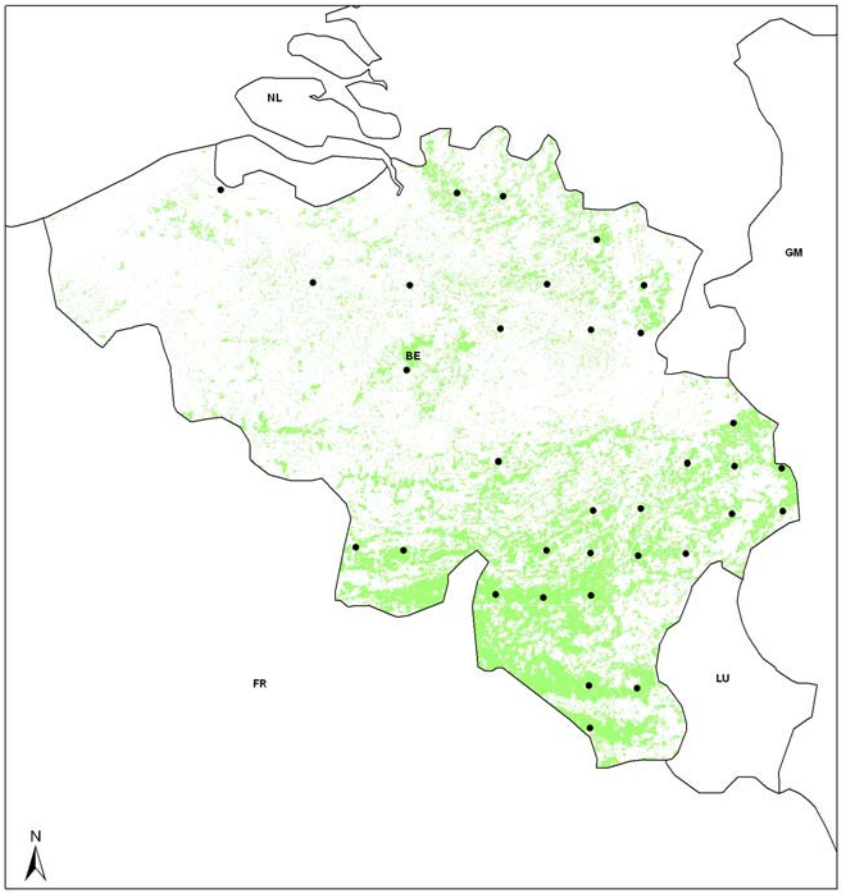


Table 5. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Belgium	12	0	0	0	21	0	0	0	0	33

Table 6. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Belgium	0	5	0	4	4	5	0	0	0	0	0	0	0	15	33

Figure 14. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

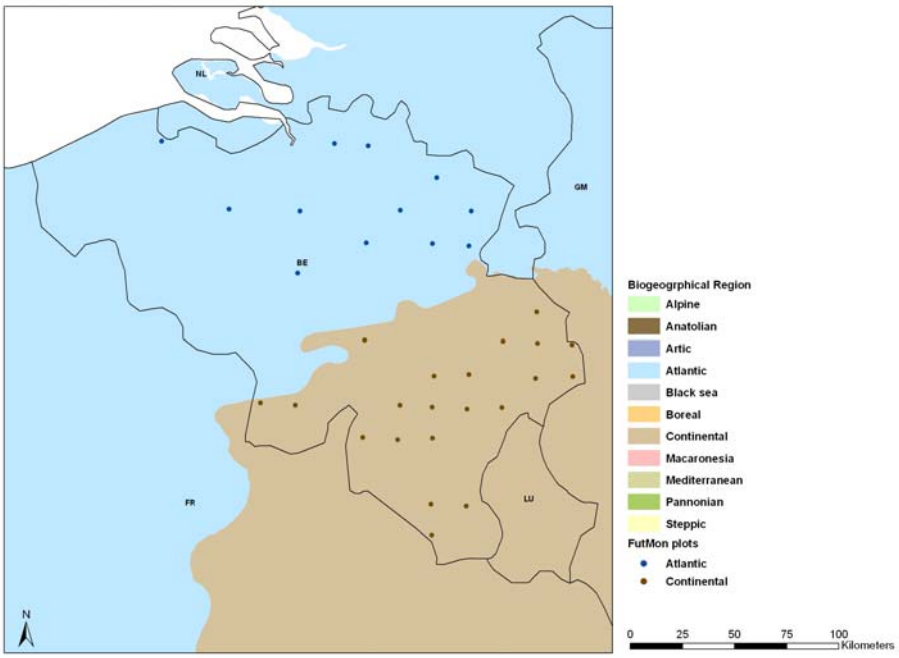
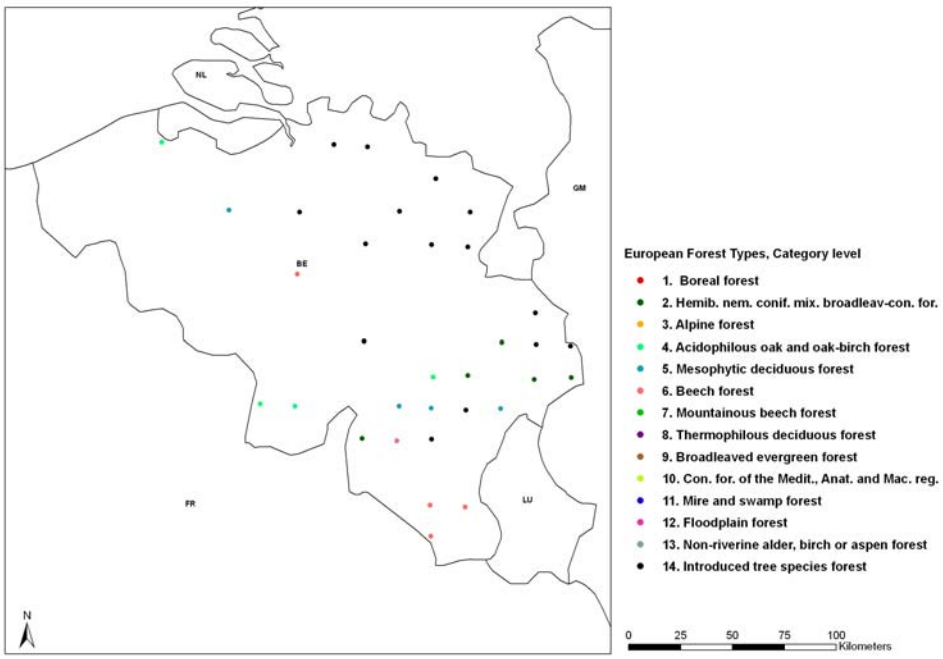


Figure 15. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.3 Bulgaria

Total number of FutMon large-scale plots: 159 (Figure 16).

Relationships with existing monitoring networks: part (90) of FutMon plots were selected for the first time (new FutMon plot); the remaining plots (69) coincide with ICP Level I plots; in Bulgaria there are no NFI monitoring network; Bulgaria didn't participate to the Biosoil project.

Biogeographical regions: 57% of plots are located in the Continental region; 33% of plots are in Alpine region (Table 7, Figure 17).

Forest types at category level (EEA): the most part of plots are located in the following categories: Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest (31%); Beech forest (20%); Thermophilous deciduous forest (18%) (Table 8, Figure 18).

Representativity: the total number of FutMon large-scale plots is greater than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 16. Distribution of FutMon plots over forest-non forest map.

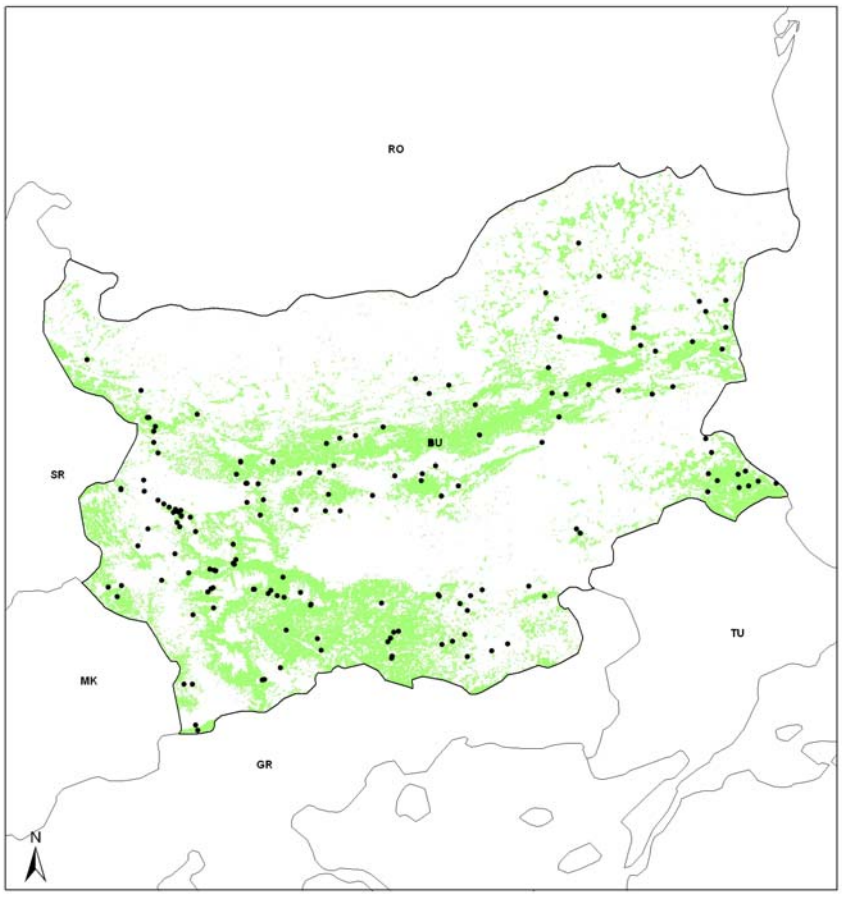


Table 7. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Bulgaria	53	0	16	0	90	0	0	0	0	159

Table 8. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Bulgaria	0	49	6	10	10	32	10	28	0	0	0	0	0	14	159

Figure 17. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

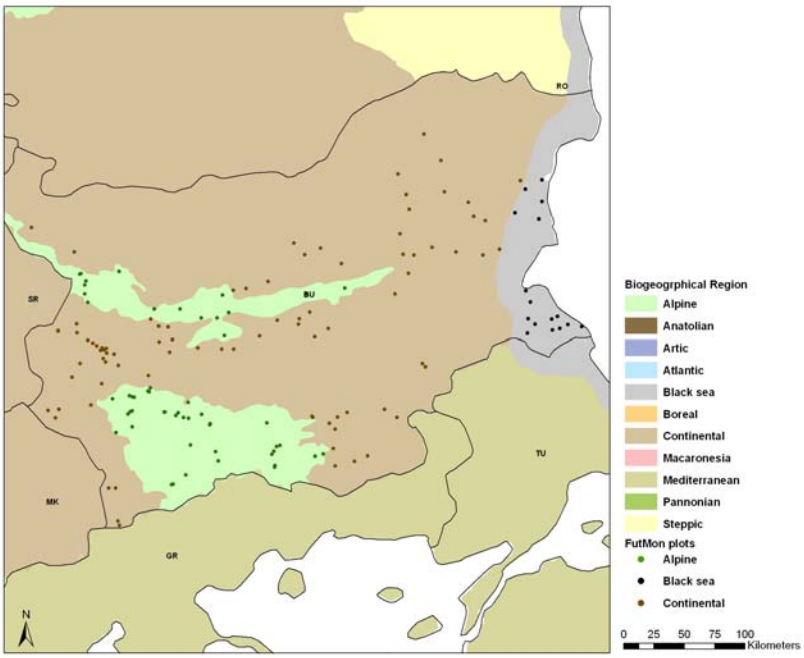
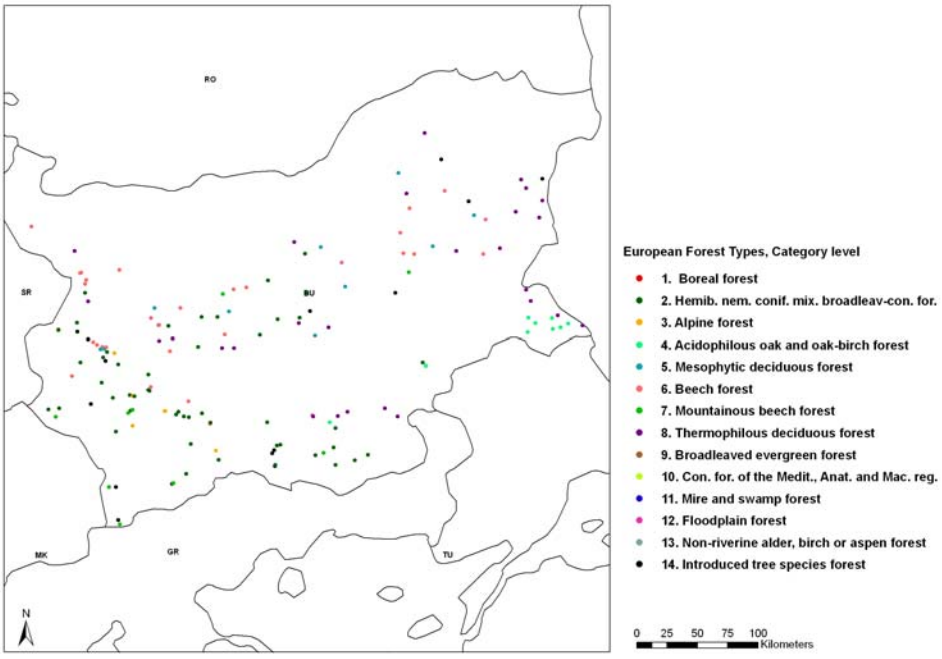


Figure 18. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.4 Cyprus

Total number of FutMon large-scale plots: 15 (Figure 19).

Relationships with existing monitoring networks: full integration between FutMon, ICP Level I and NFI plots. Information on the relationships between FutMon and Biosoil plots is missing.

Biogeographical regions: all plots are in the Mediterranean region (Table 9, Figure 20).

Forest types at category level (EEA): all plots are Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions (Table 10, Figure 21).

Representativity: the total number of FutMon large-scale plots is less than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 19. Distribution of FutMon plots over forest-non forest map.

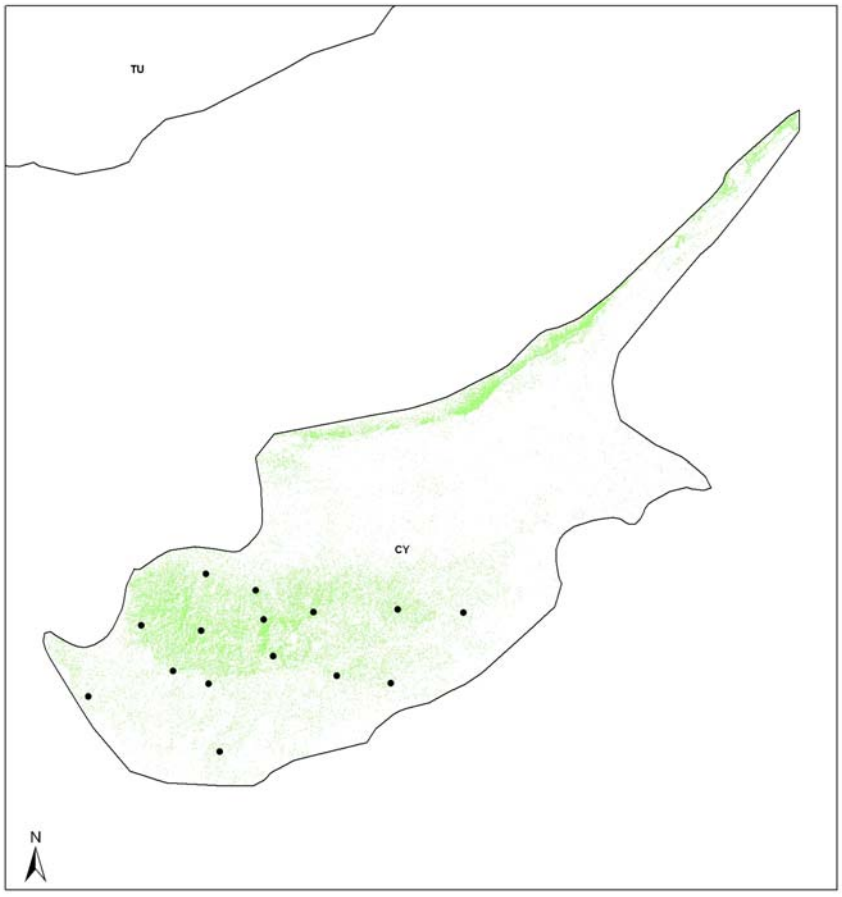


Table 9. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Cyprus	0	0	0	0	0	0	15	0	0	15

Table 10. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Cyprus	0	0	0	0	0	0	0	0	0	15	0	0	0	0	15

Figure 20. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

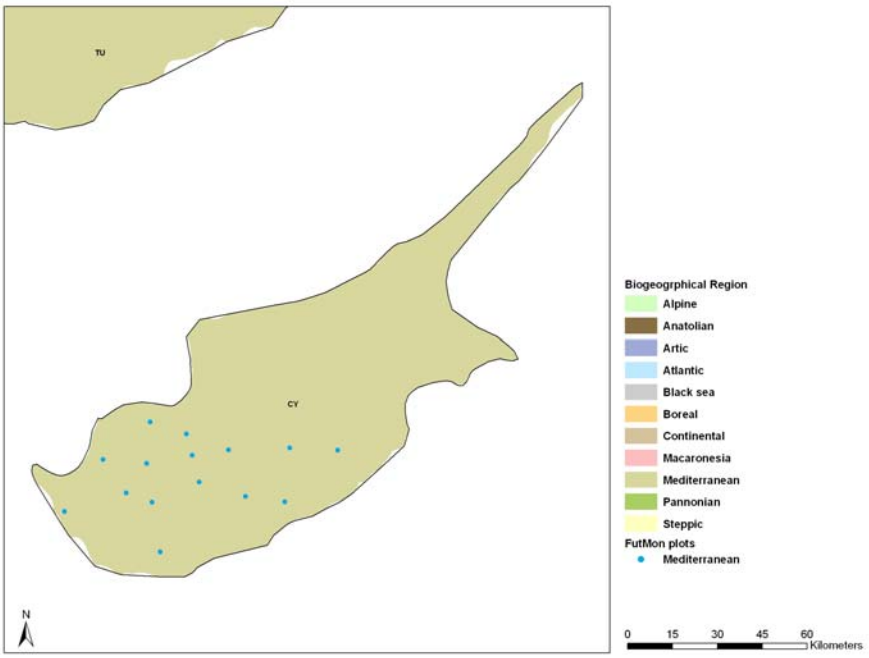
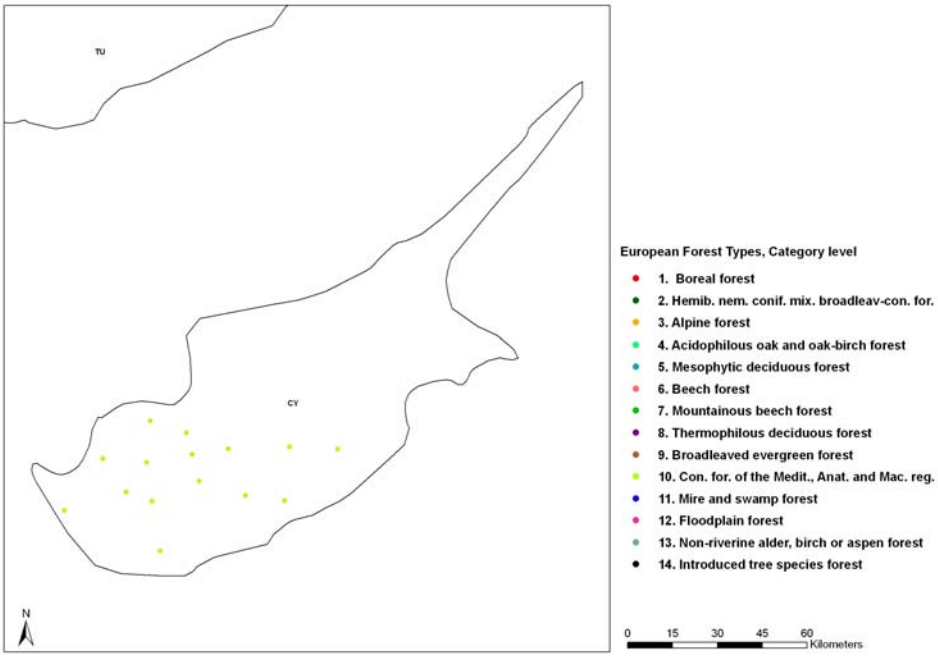


Figure 21. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.5 Czech Republic

Total number of FutMon large-scale plots: 516 (Figure 22).

Relationships with existing monitoring networks: full integration between FutMon and ICP Level I plots; no relationship between FutMon and NFI plots. Information on the relationships between FutMon and Biosoil plots is missing.

Biogeographical regions: the most part of plots (97%) are located in the Continental region (Table 11, Figure 23).

Forest types at category level (EEA): the most part of plots (77%) are Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest (Table 12, Figure 24).

Representativity: the total number of FutMon large-scale plots is greater than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 22. Distribution of FutMon plots over forest-non forest map.

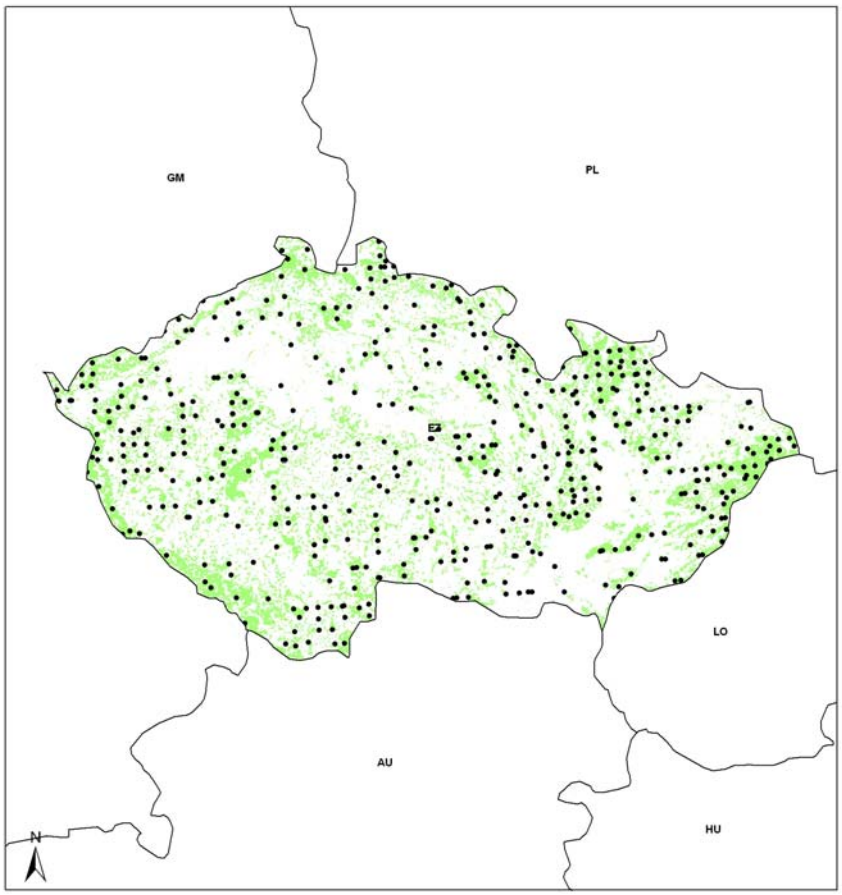


Table 11. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Czech Rep.	6	0	0	0	498	0	0	12	0	516

Table 12. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Czech R.	0	398	11	2	26	11	12	0	0	0	0	2	7	47	516

Figure 23. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

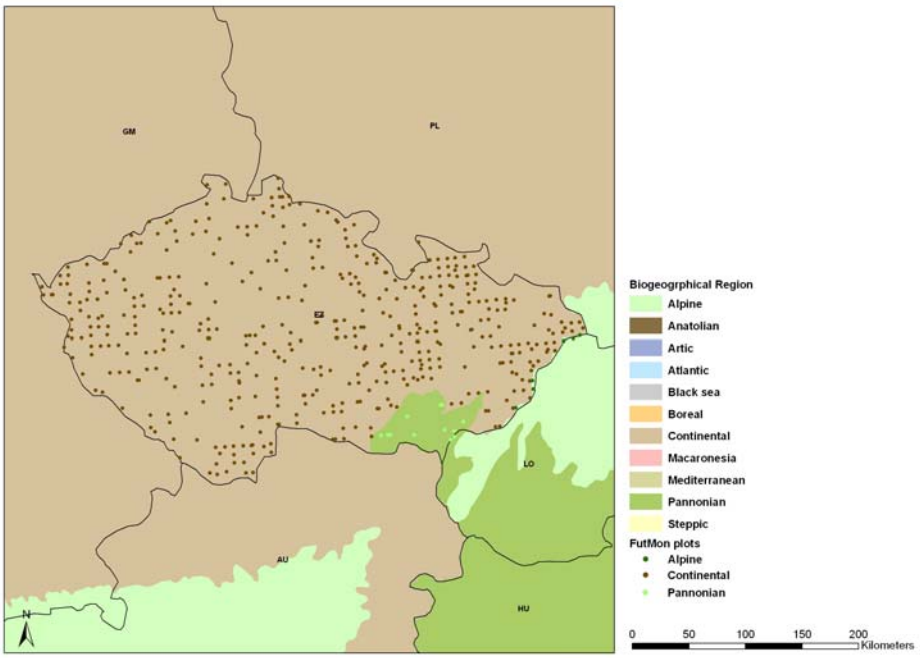
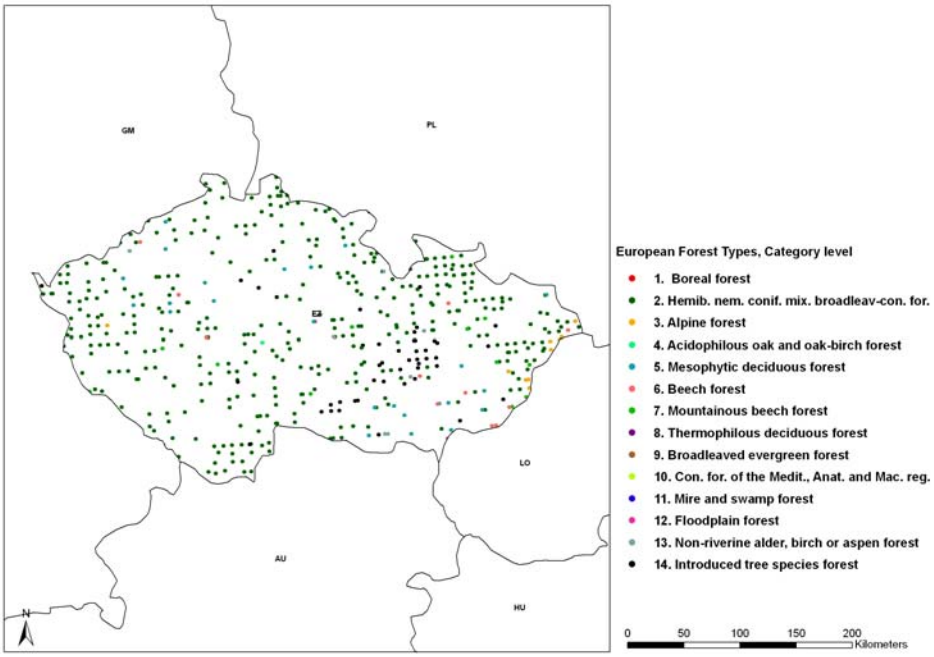


Figure 24. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.6 Denmark

Total number of FutMon large-scale plots: 24 (Figure 25).

Relationships with existing monitoring networks: full integration between FutMon, ICP Level I and Biosoil plots; no relationship between FutMon and NFI plots.

Biogeographical regions: 63% of plots are located in the Continental region; 38% of plots are in the Atlantic region (Table 13, Figure 26).

Forest types at category level (EEA): the most part of plots are in the following categories: Introduced tree species forest (46%); Beech forest (38%) (Table 14, Figure 27).

Representativity: the total number of FutMon large-scale plots is less than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 25. Distribution of FutMon plots over forest-non forest map.

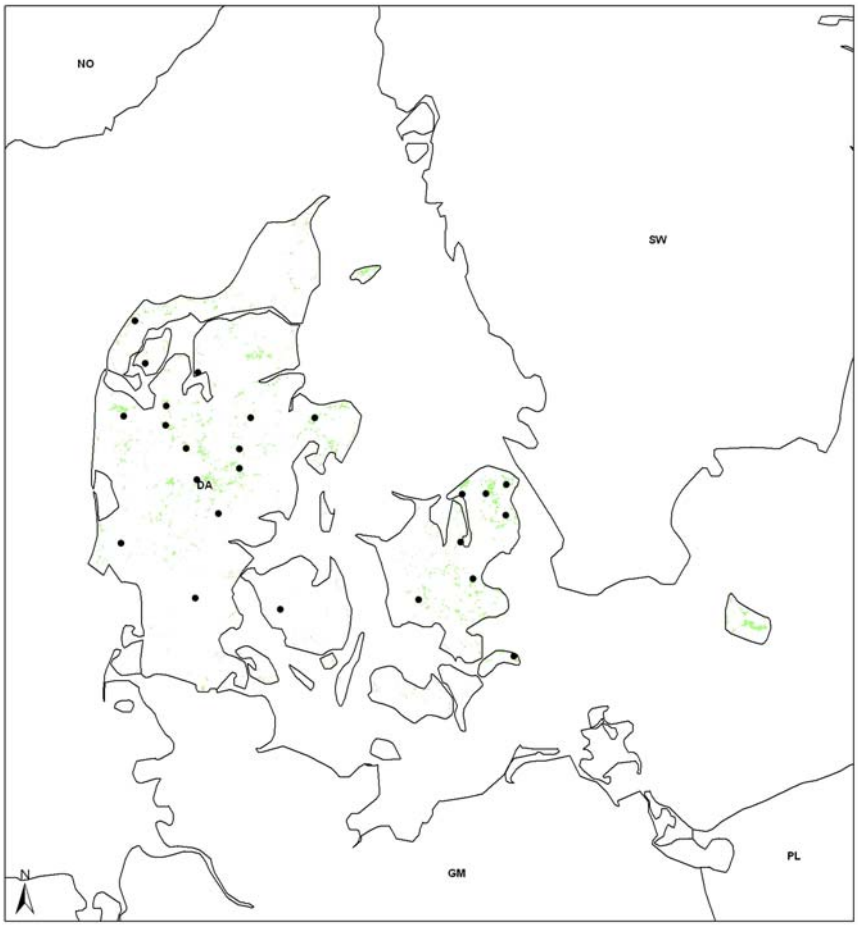


Table 13. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Denmark	0	9	0	0	15	0	0	0	0	24

Table 14. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Denmark	0	0	0	0	4	9	0	0	0	0	0	0	0	11	24

Figure 26. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

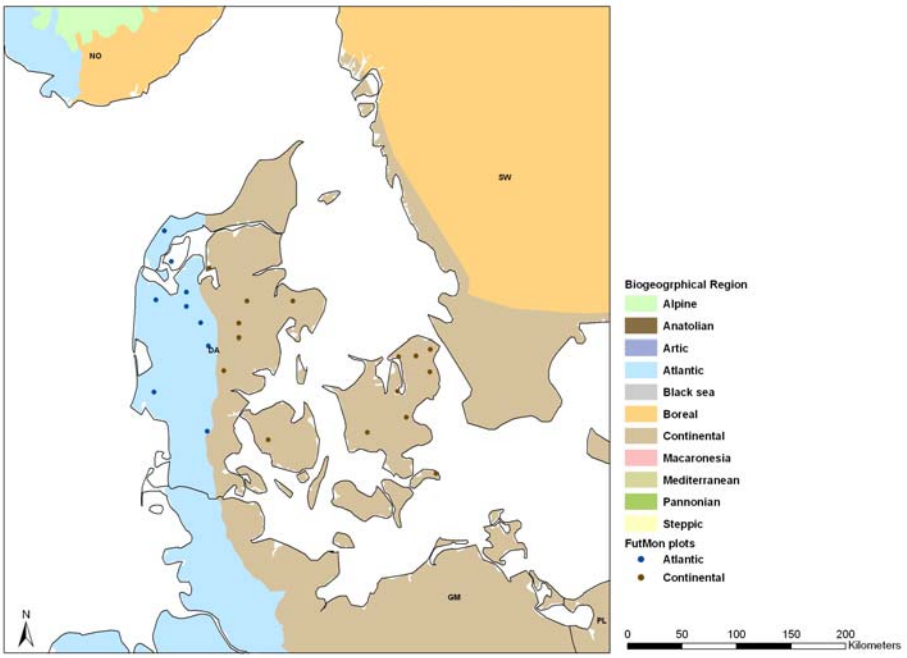
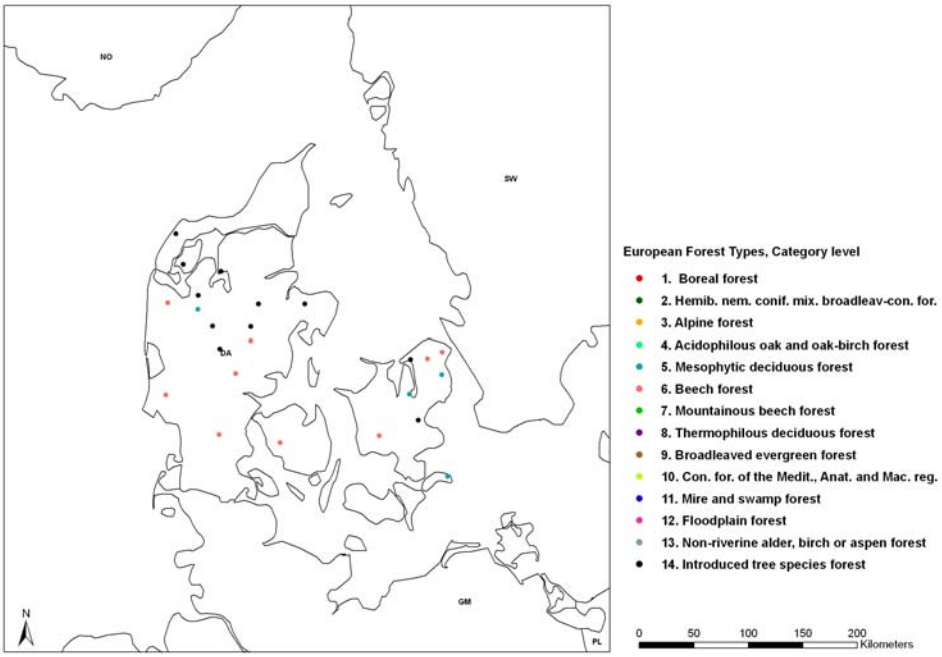


Figure 27. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.7 Estonia

Total number of FutMon large-scale plots: 101 (Figure 28).

Relationships with existing monitoring networks: full integration between FutMon, ICP Level I and Biosoil plots; part (10) of FutMon plots coincide with NFI plots.

Biogeographical regions: all plots are in the Boreal region (Table 15, Figure 29).

Forest types at category level (EEA): the most part of plots are in the following categories: Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest (78%); Mire and swamp forest (11%) (Table 16, Figure 30).

Representativity: the total number of FutMon large-scale plots is less than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 28. Distribution of FutMon plots over forest-non forest map.

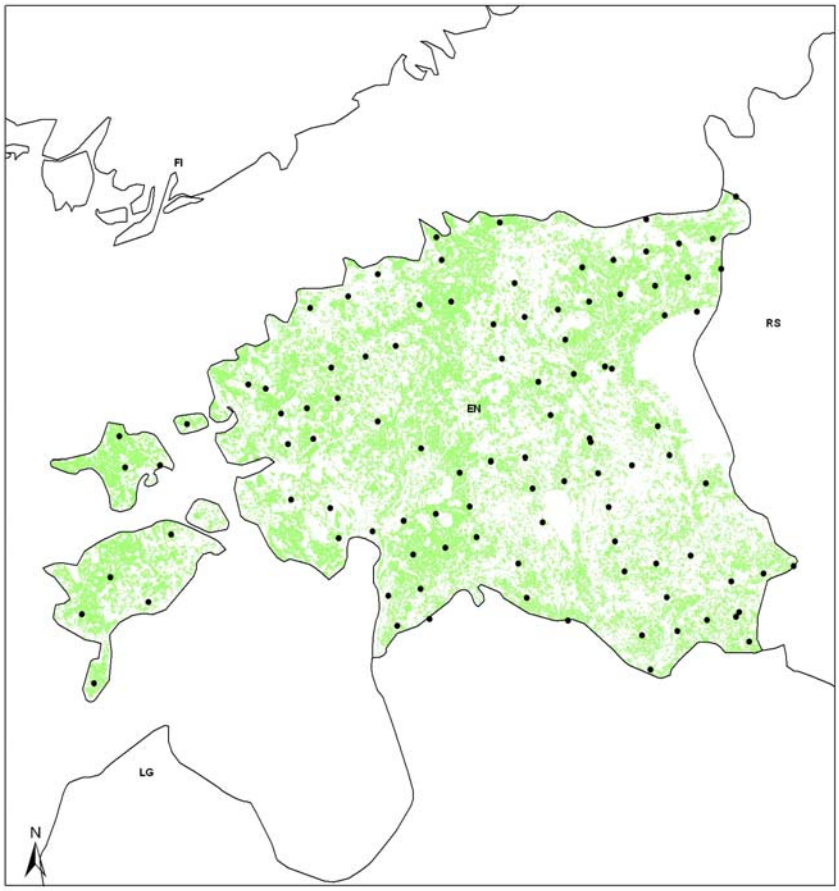


Table 15. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Estonia	0	0	0	101	0	0	0	0	0	101

Table 16. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Estonia	7	79	0	0	1	0	0	0	0	0	11	0	3	0	101

Figure 29. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

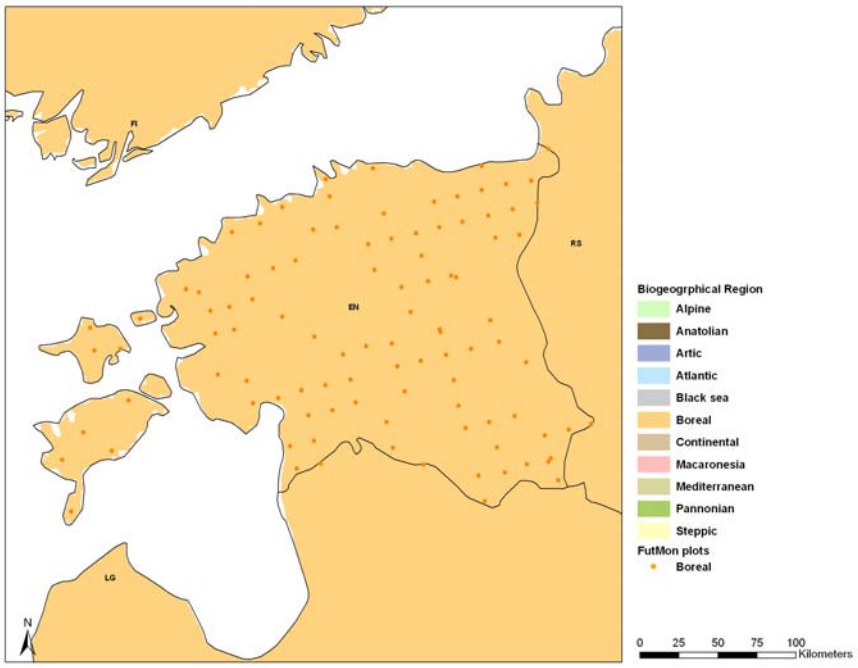
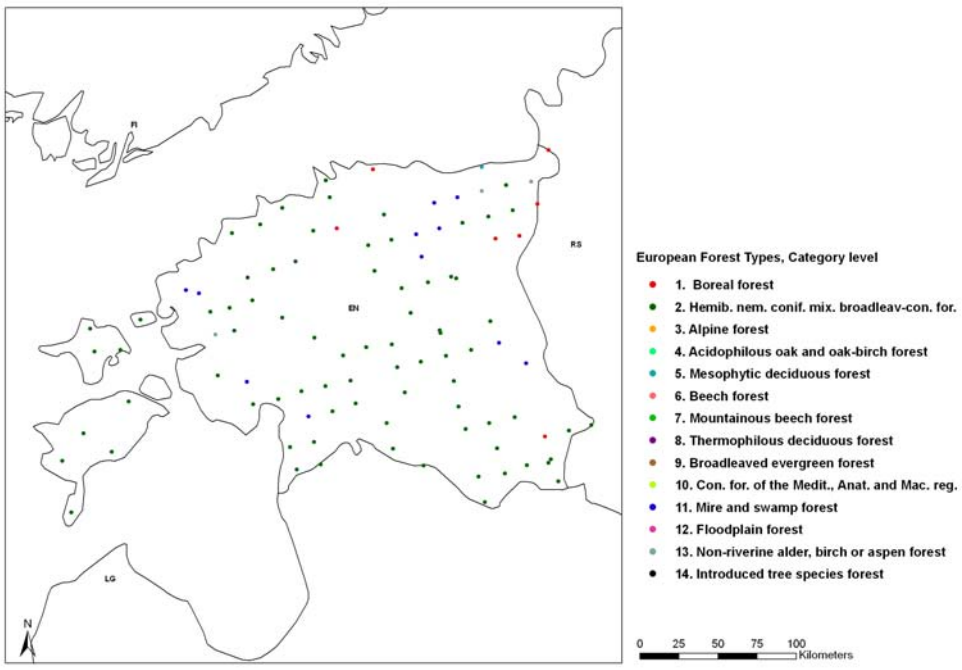


Figure 30. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.8 Finland

Total number of FutMon large-scale plots: 886 (Figure 31).

Relationships with existing monitoring networks: full integration between FutMon, ICP Level I and NFI plots. Information on the relationships between FutMon and Biosoil plots is missing.

Biogeographical regions: all plots are in the Boreal region (Table 17, Figure 32).

Forest types at category level (EEA): the most part of plots (98%) are Boreal forest (Table 18, Figure 33).

Representativity: the total number of FutMon large-scale plots is greater than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 31. Distribution of FutMon plots over forest-non forest map.

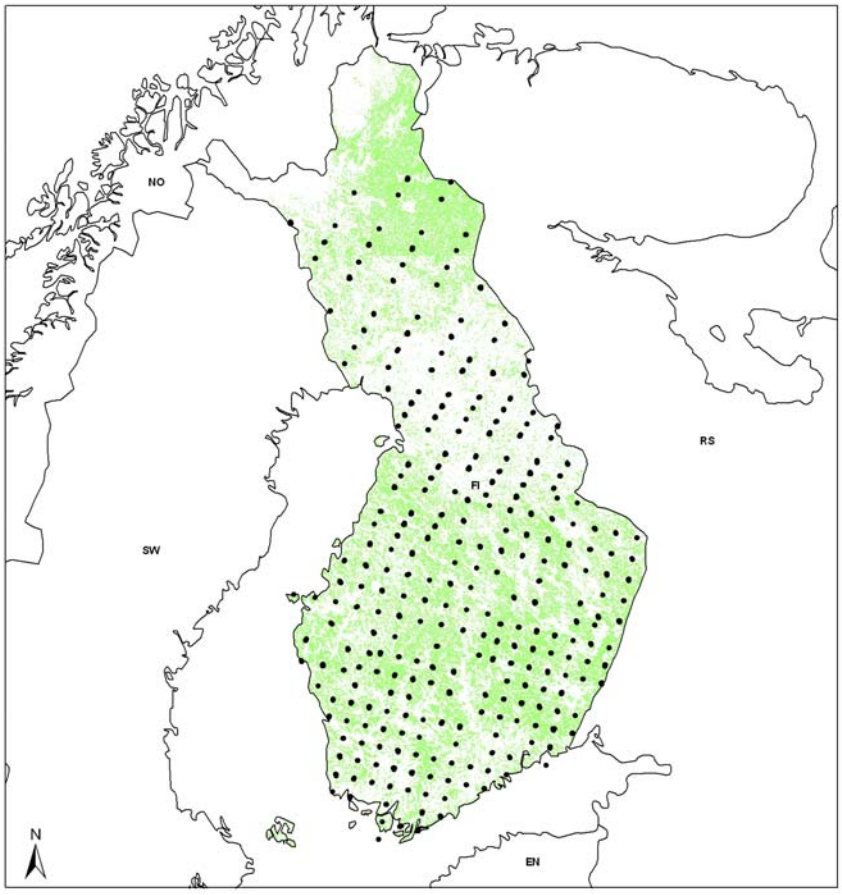


Table 17. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Finland	0	0	0	886	0	0	0	0	0	886

Table 18. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Finland	865	17	0	0	0	0	0	0	0	0	0	0	4	0	886

Figure 32. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

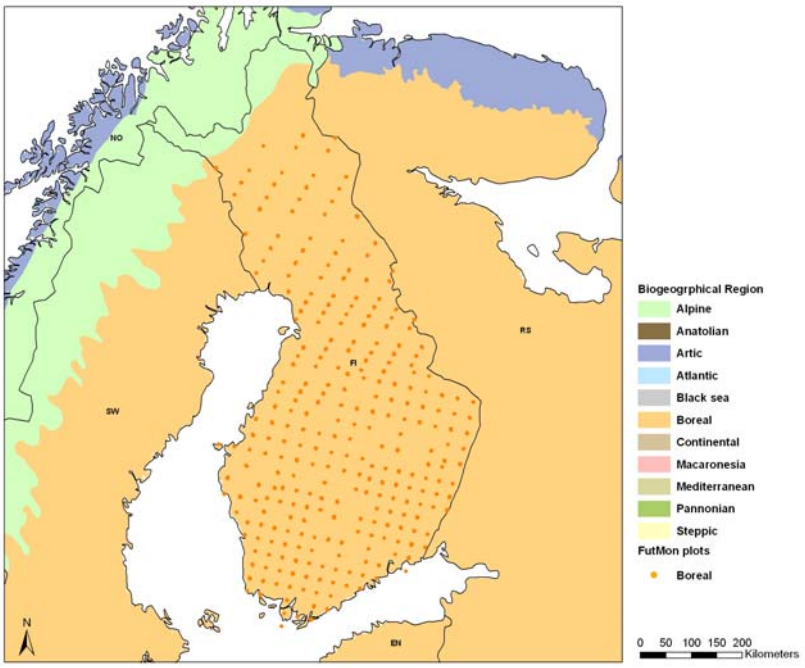
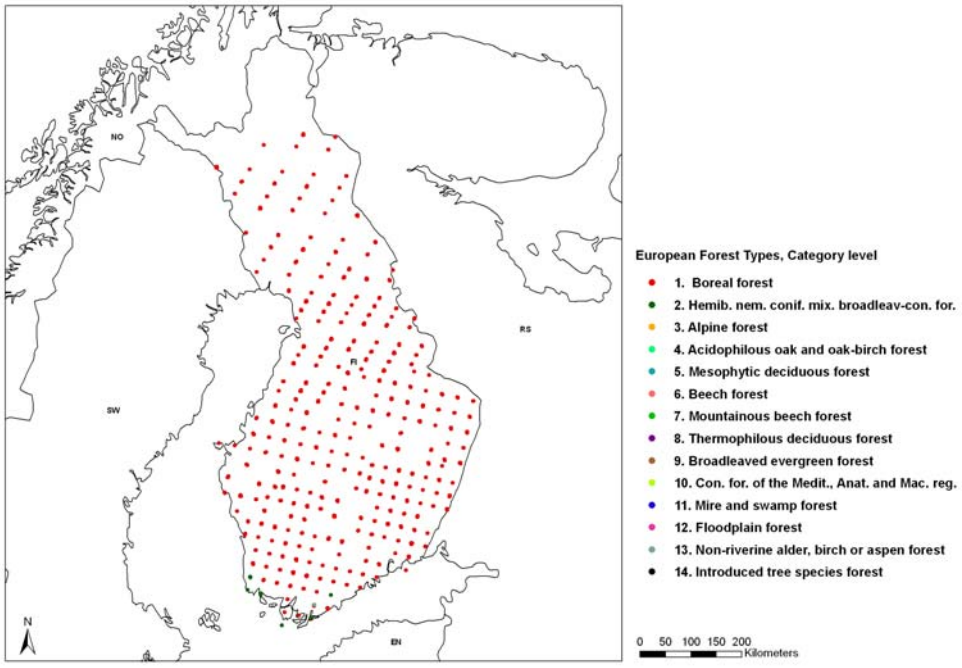


Figure 33. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.9 France

Total number of FutMon large-scale plots: 585 (Figure 34).

Relationships with existing monitoring networks: full integration between FutMon and ICP Level I. Information on the relationships between FutMon, NFI and Biosoil plots is missing.

Biogeographical regions: the most part of plots are in the Continental (42%) and Atlantic (35%) regions (Table 19, Figure 35).

Forest types at category level (EEA): the most part of plots are in the following categories: Mesophytic deciduous forest (24%); Thermophilous deciduous forest (14%); Introduced tree species forest (14%) (Table 20, Figure 36).

Representativity: the total number of FutMon large-scale plots is greater than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 34. Distribution of FutMon plots over forest-non forest map.

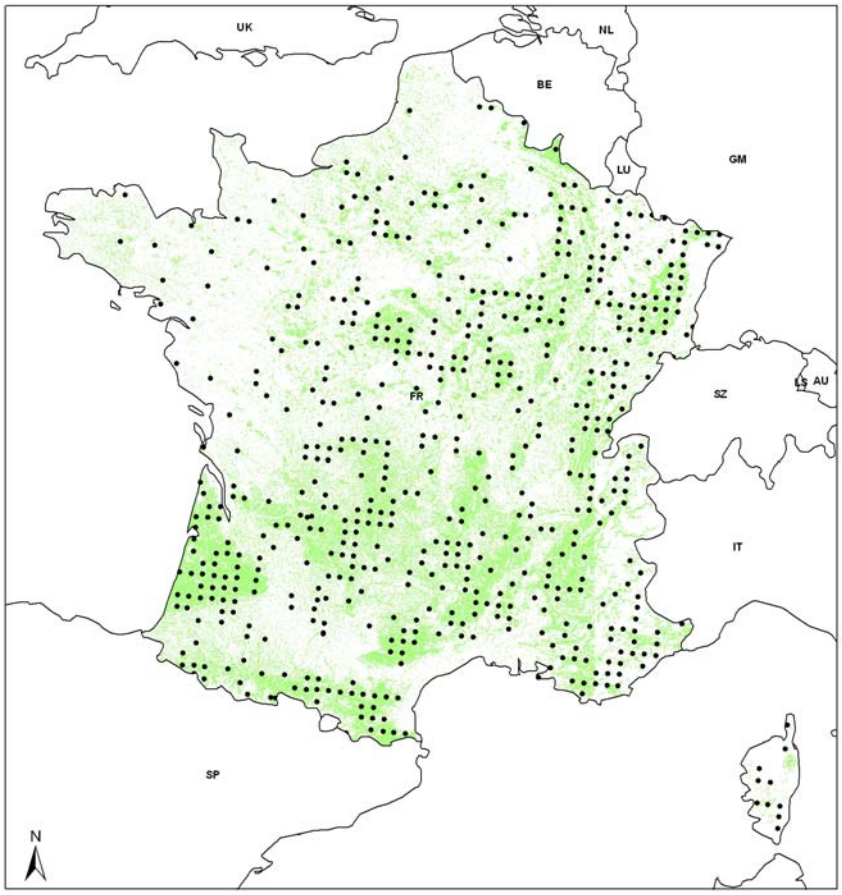


Table 19. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
France	43	207	0	0	246	0	89	0	0	585

Table 20. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
France	0	32	52	37	139	39	28	80	21	54	0	8	11	84	585

Figure 35. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

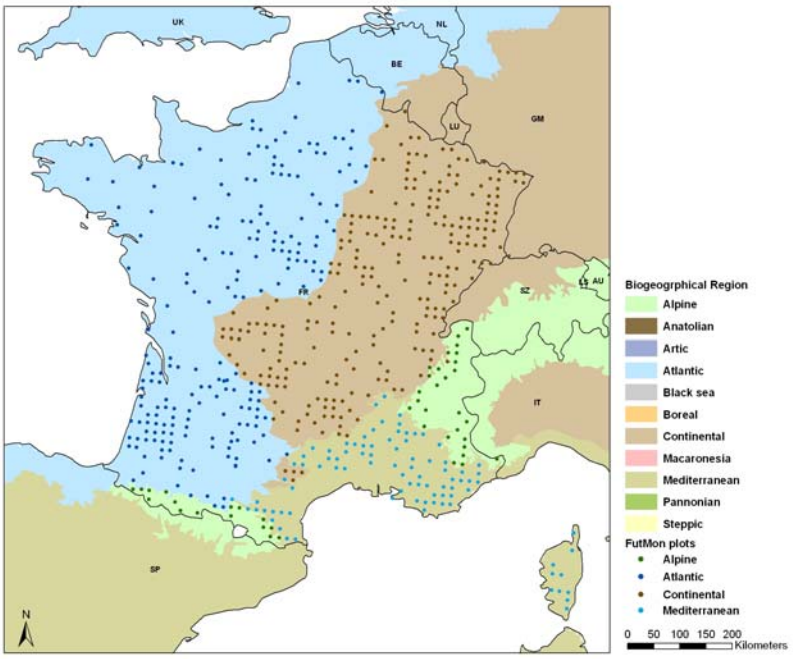
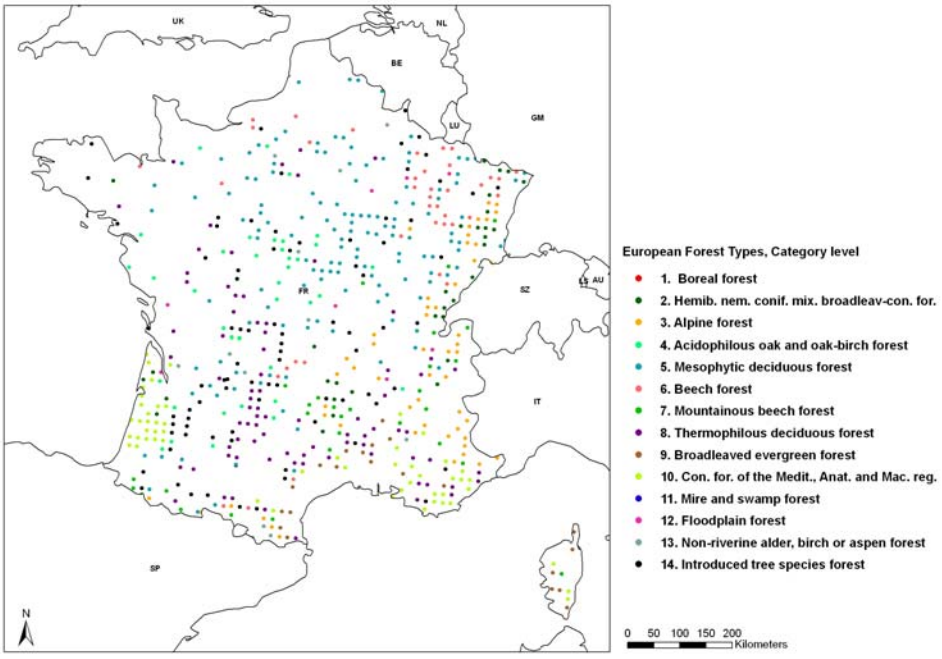


Figure 36. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.10 Germany

Total number of FutMon large-scale plots: 600 (Figure 37).

Relationships with existing monitoring networks: part (45) of FutMon plots were selected for the first time; the remaining plots (555) coincide with ICP Level I plots. Full integration between FutMon, NFI and Biosoil plots.

Biogeographical regions: the most part of plots (90%) are in the Continental region (Table 21, Figure 38).

Forest types at category level (EEA): the most part of plots are in the following categories: Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest (55%); Beech forest (11%); Introduced tree species forest (12%) (Table 22, Figure 39).

Representativity: the total number of FutMon large-scale plots is greater than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 37. Distribution of FutMon plots over forest-non forest map.

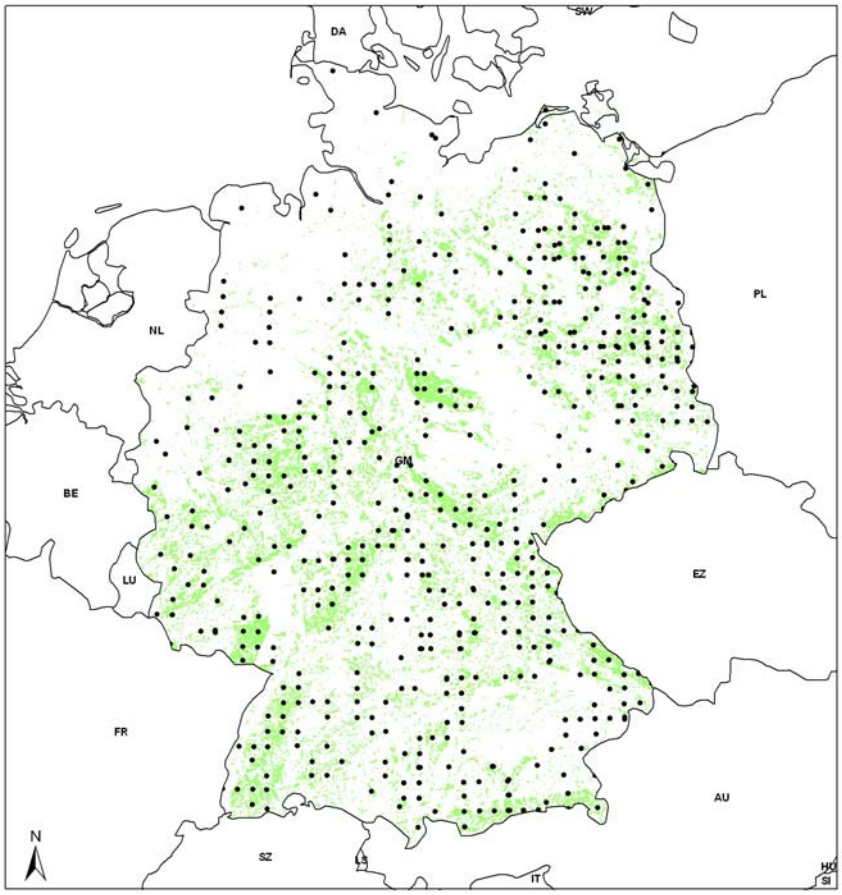


Table 21. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Germany	18	43	0	0	539	0	0	0	0	600

Table 22. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Germany	0	332	24	5	39	67	38	0	0	0	3	5	16	71	600

Figure 38. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

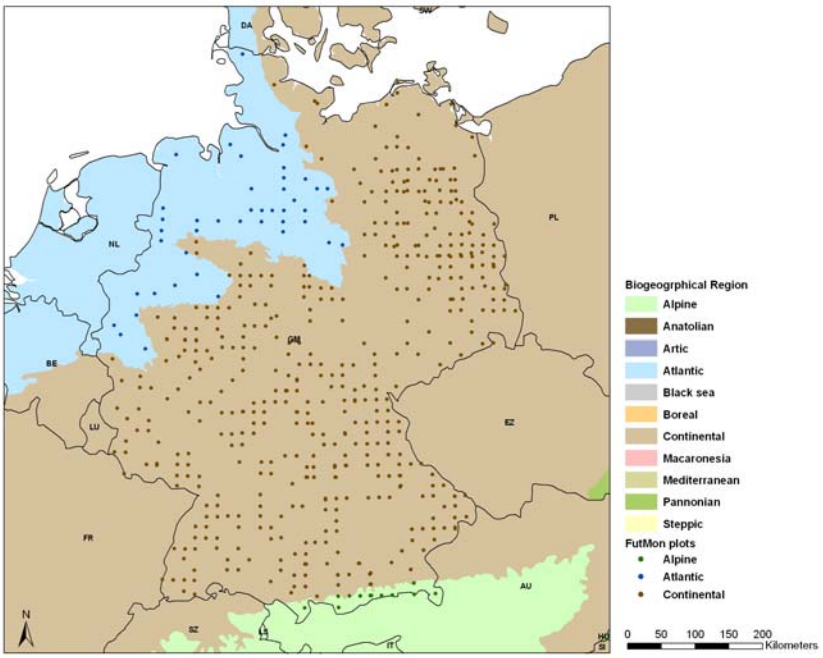
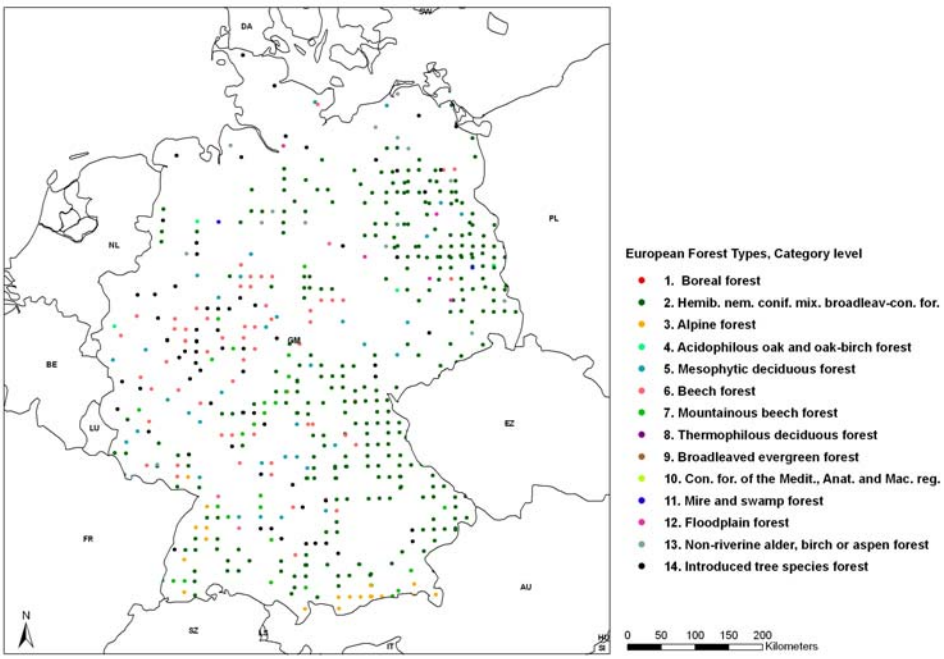


Figure 39. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.11 Greece

Total number of FutMon large-scale plots: 147 (Figure 40).

Relationships with existing monitoring networks: part (38) of FutMon plots were selected for the first time; the remaining plots (109) coincide with ICP Level I plots. No relationship between FutMon and NFI plots. Information on the relationships between FutMon and Biosoil plots is missing.

Biogeographical regions: all plots are in the Mediterranean region (Table 23, Figure 41).

Forest types at category level (EEA): the most part of plots are in the following categories: Thermophilous deciduous forest (24%); Broadleaved evergreen forest (14%); Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions (46%) (Table 24, Figure 42).

Figure 40. Distribution of FutMon plots over forest-non forest map.

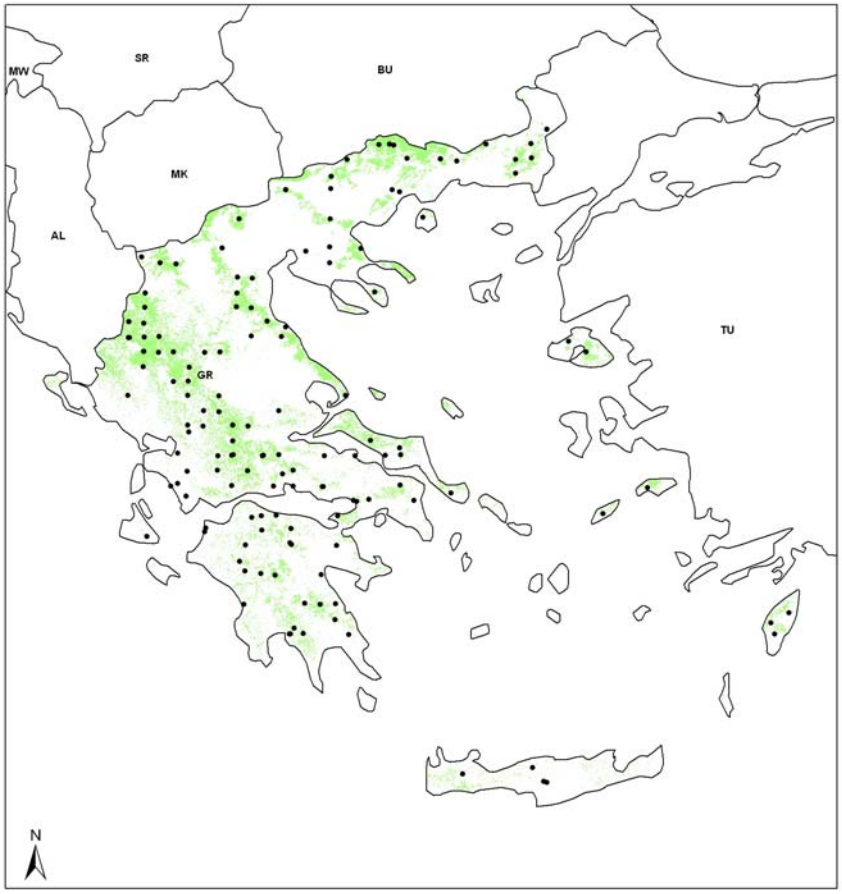


Table 23. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Greece	0	0	0	0	0	0	147	0	0	147

Table 24. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Greece	0	0	0	0	8	3	9	35	21	68	0	0	0	3	147

Figure 41. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

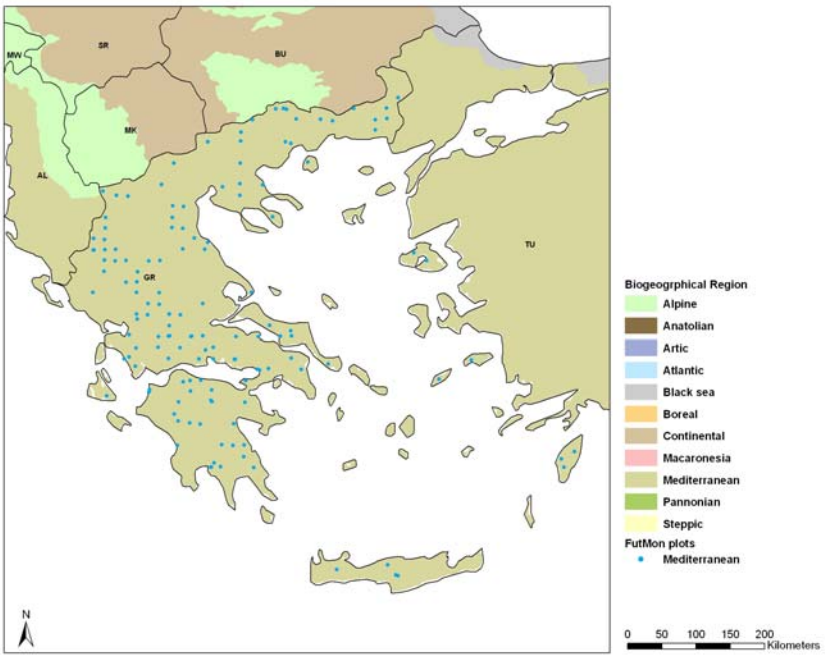
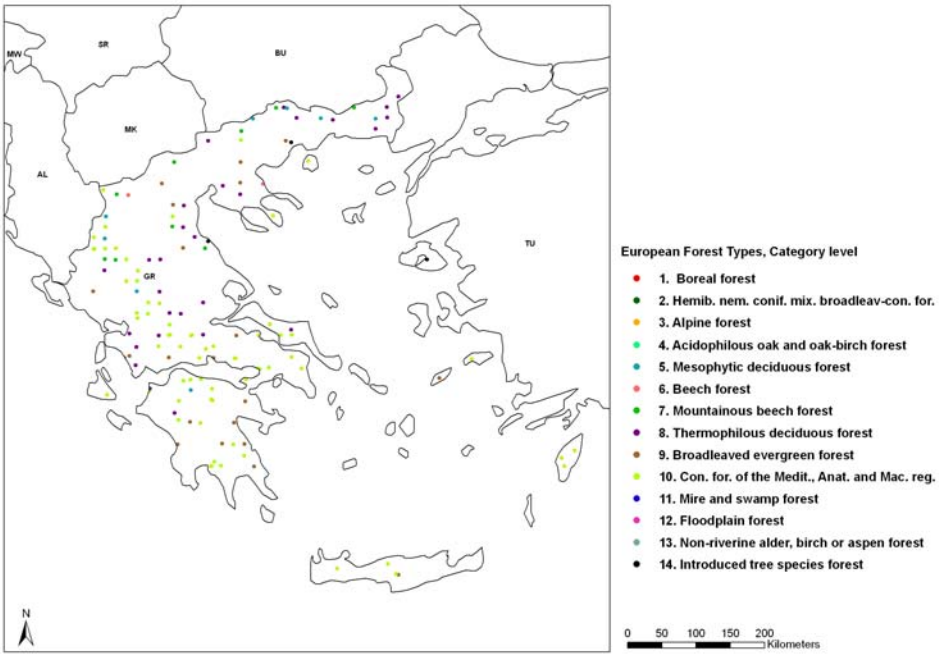


Figure 42. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.12 Hungary

Total number of FutMon large-scale plots: 79 (Figure 43).

Relationships with existing monitoring networks: full integration between FutMon, ICP Level I and Biosoil plots. Part of FutMon plots coincide with NFI plots.

Biogeographical regions: all plots are in the Pannonian region (Table 25, Figure 44).

Forest types at category level (EEA): the most part of plots are in the following categories: Mesophytic deciduous forest (19%); Thermophilous deciduous forest (19%); Introduced tree species forest (38%) (Table 26, Figure 45).

Figure 43. Distribution of FutMon plots over forest-non forest map.

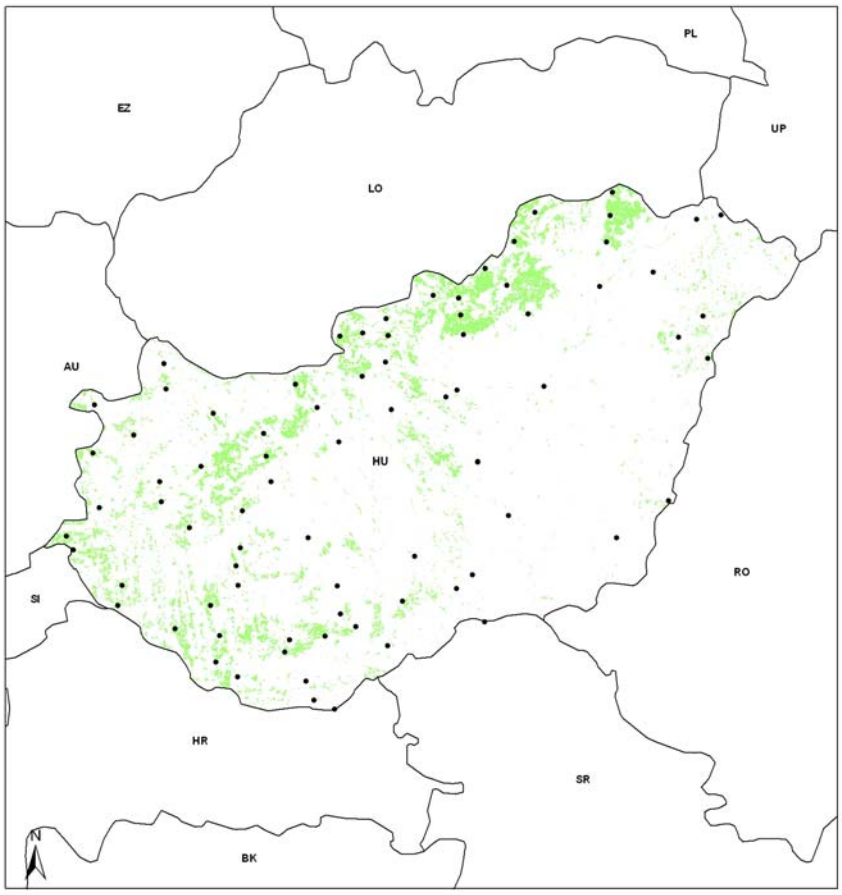


Table 25. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Hungary	0	0	0	0	0	0	0	79	0	79

Table 26. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Hungary	0	4	0	0	15	6	0	15	0	0	0	4	5	30	79

Figure 44. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

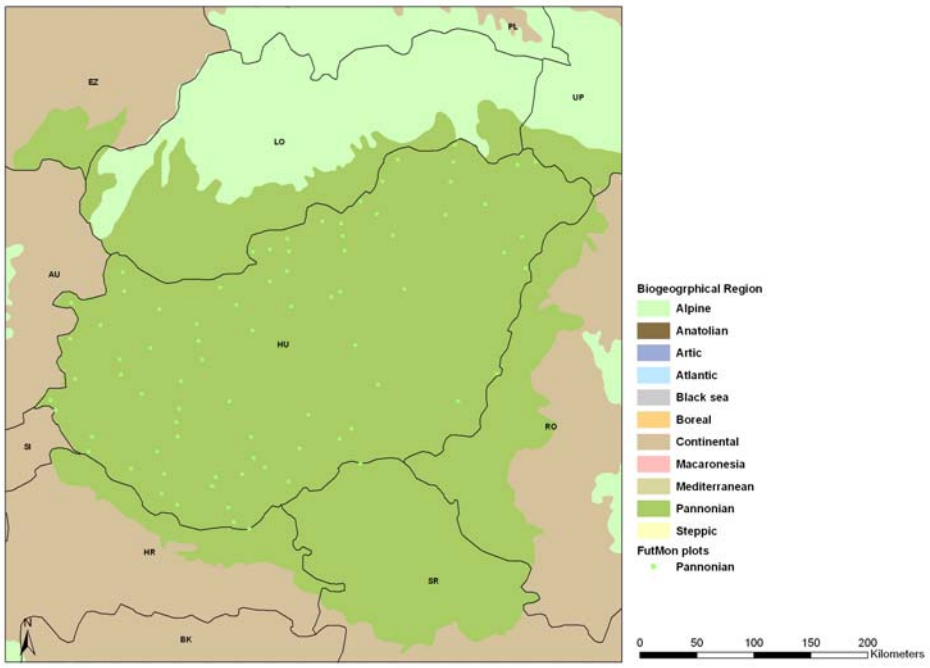
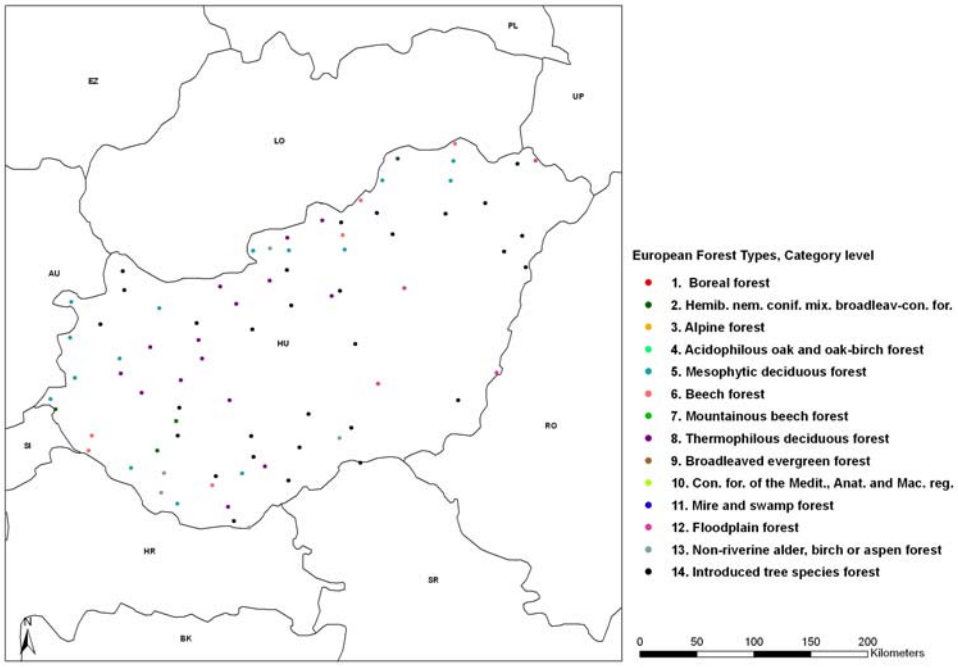


Figure 45. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.13 Ireland

Total number of FutMon large-scale plots: 59 (Figure 46).

Relationships with existing monitoring networks: full integration between FutMon and ICP Level I plots; part of FutMon plots coincide with NFI plots; information on the relationship between FutMon and Biosoil plots is missing.

Biogeographical regions: all plots are in the Atlantic region (Table 27, Figure 47).

Forest types at category level (EEA): all plots are Introduced tree species forest (Table 28, Figure 48).

Representativity: the total number of FutMon large-scale plots is less than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 46. Distribution of FutMon plots over forest-non forest map.

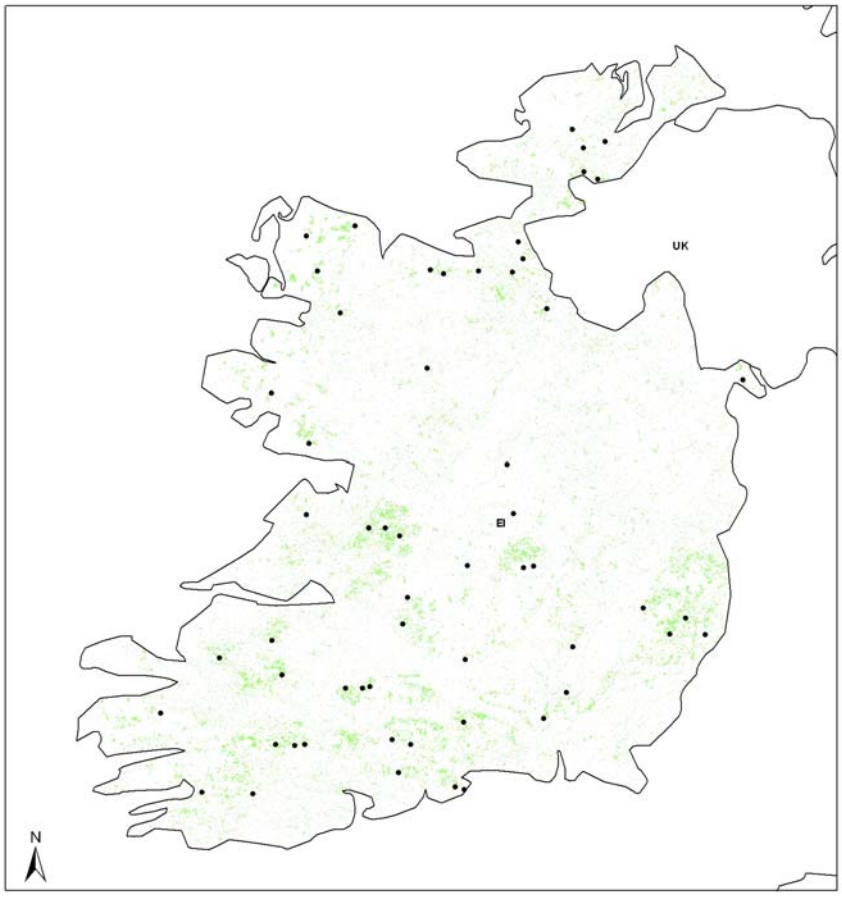


Table 27. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Ireland	0	59	0	0	0	0	0	0	0	59

Table 28. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	59	59

Figure 47. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

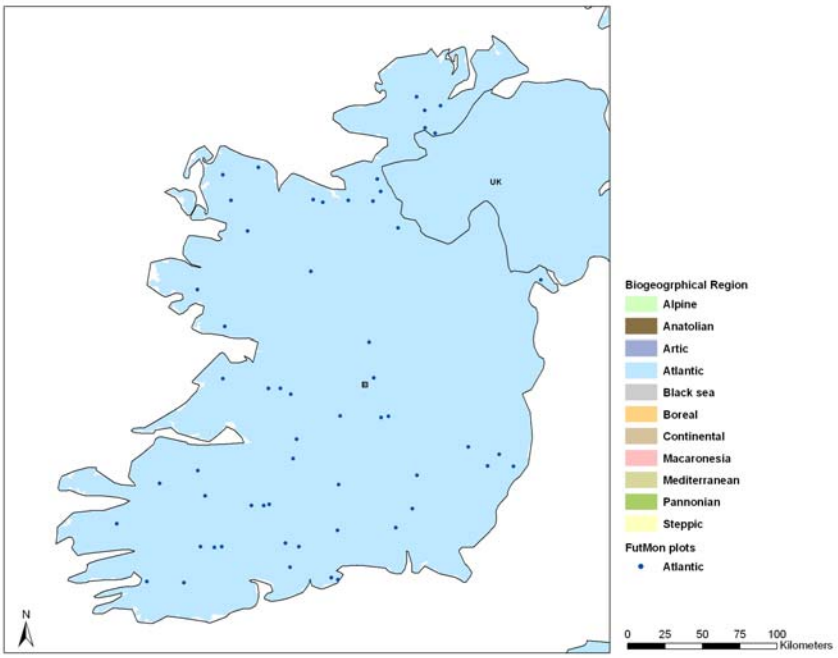
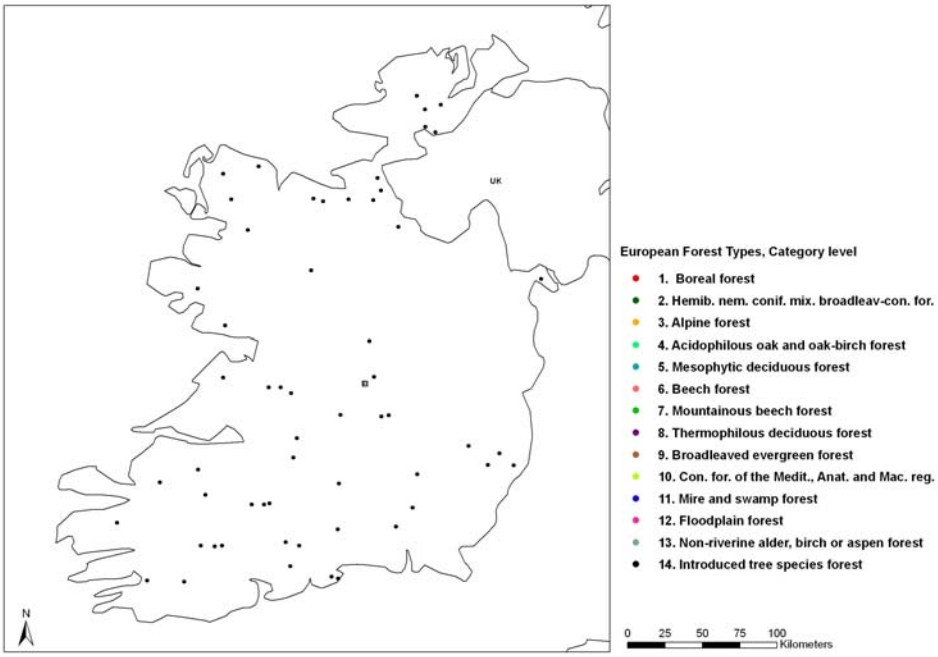


Figure 48. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.14 Italy

Total number of FutMon large-scale plots: 313 (Figure 49).

Relationships with existing monitoring networks: full integration between FutMon and ICP Level I plots; no relationship between FutMon and NFI plots; information on the relationship between FutMon and Biosoil plots is missing.

Biogeographical regions: 44% of plots are in the Mediterranean region; 36% of plots are in the Alpine region; 20% of plots are in the Continental region (Table 29, Figure 50).

Forest types at category level (EEA): the most part of plots are in the following categories: Alpine forest (20%); Mountainous beech forest (13%); Thermophilous deciduous forest (41%) (Table 30, Figure 51).

Representativity: the total number of FutMon large-scale plots is greater than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 49. Distribution of FutMon plots over forest-non forest map.

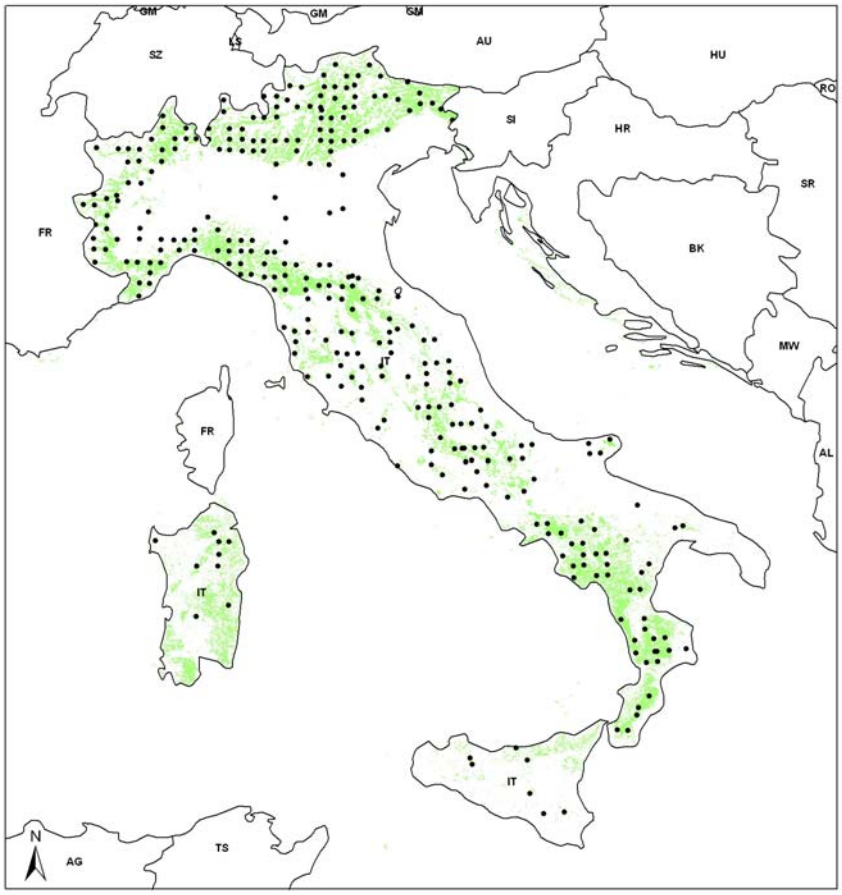


Table 29. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Italy	113	0	0	0	61	0	139	0	0	313

Table 30. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Italy	0	1	62	2	4	8	42	129	16	13	0	4	11	21	313

Figure 50. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

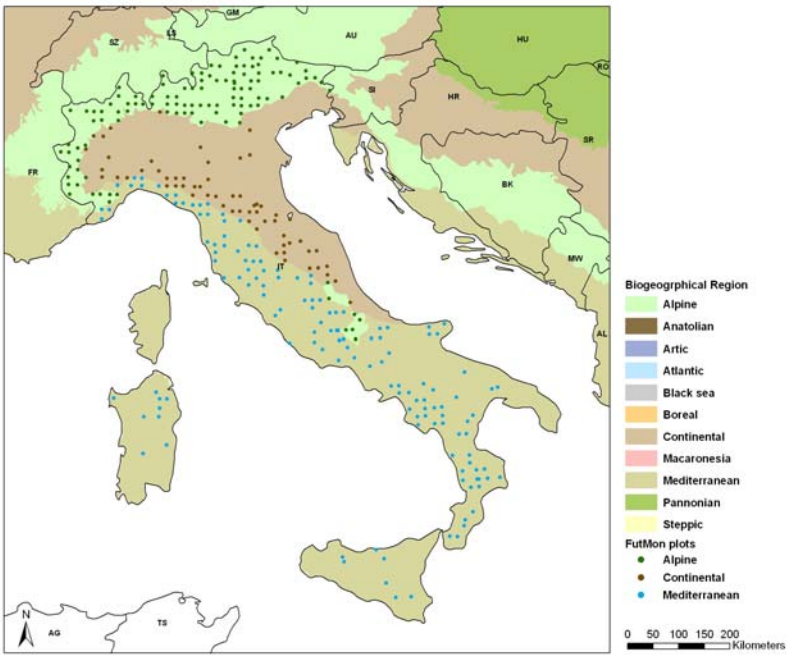
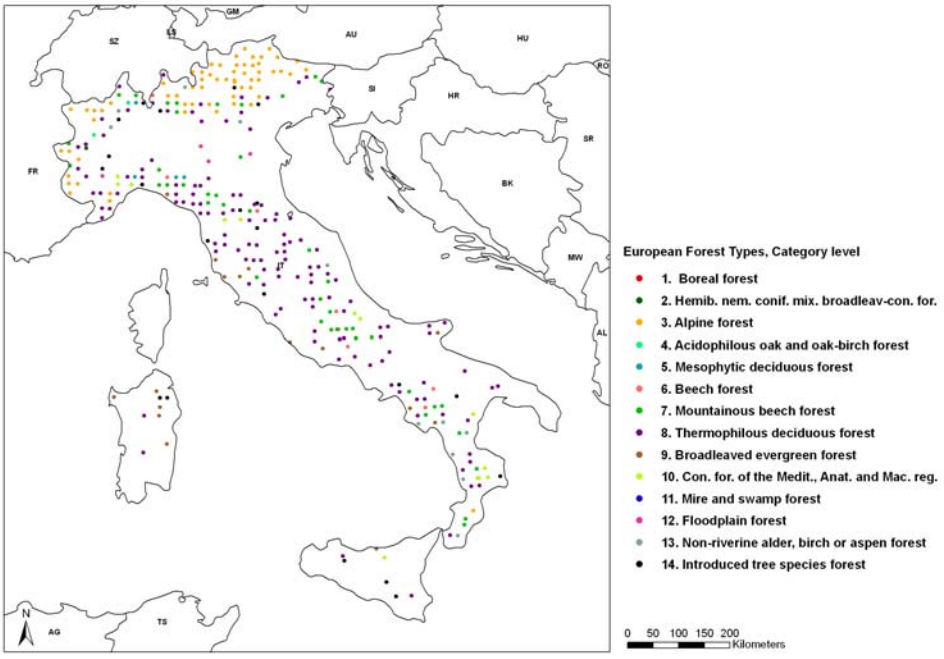


Figure 51. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.15 Latvia

Total number of FutMon large-scale plots: 115 (Figure 52).

Relationships with existing monitoring networks: all FutMon plots were selected for the first time; full integration between FutMon and NFI plots; no relationships between FutMon, ICP Level I and Biosoil plots.

Biogeographical regions: all plots are in the Boreal region (Table 31, Figure 53).

Forest types at category level (EEA): the most part of plots are in the following categories: Boreal forest (63%%); Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest (36%) (Table 32, Figure 54).

Representativity: the total number of FutMon large-scale plots is greater than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 52. Distribution of FutMon plots over forest-non forest map.

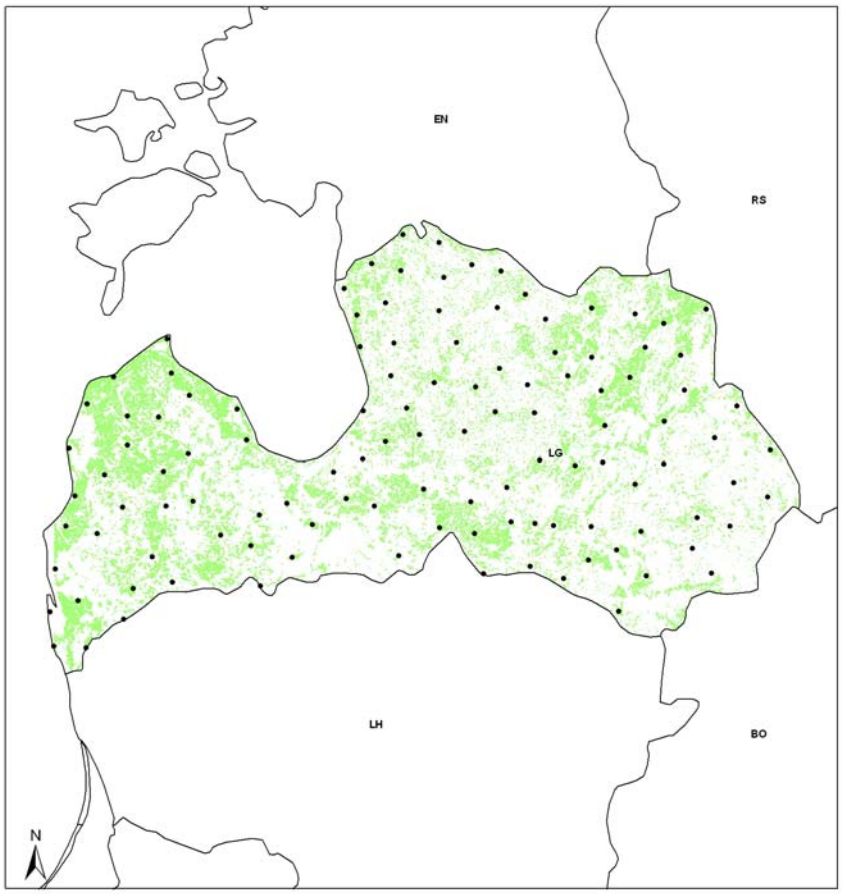


Table 31. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Latvia	0	0	0	115	0	0	0	0	0	115

Table 32. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Latvia	72	41	0	0	0	0	0	0	0	0	0	0	2	0	115

Figure 53. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

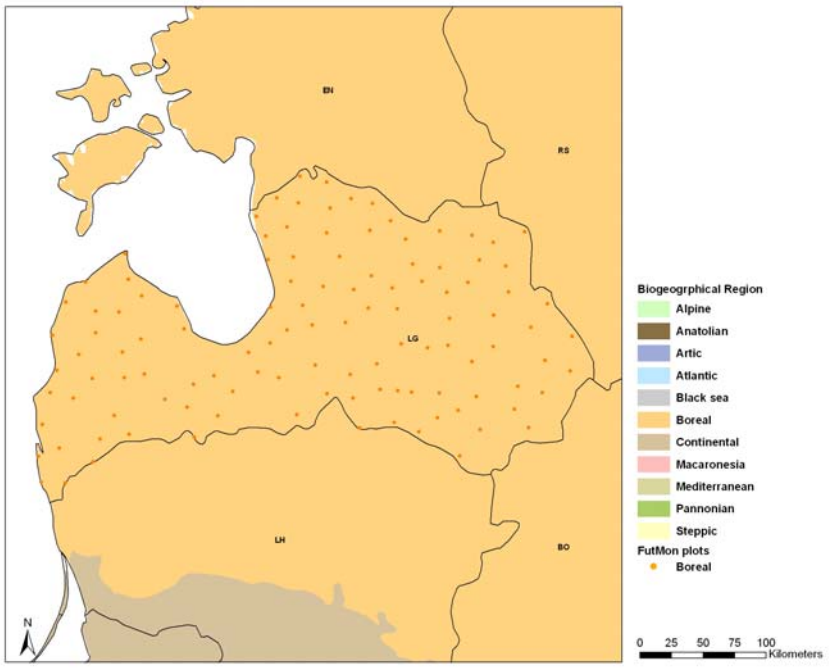
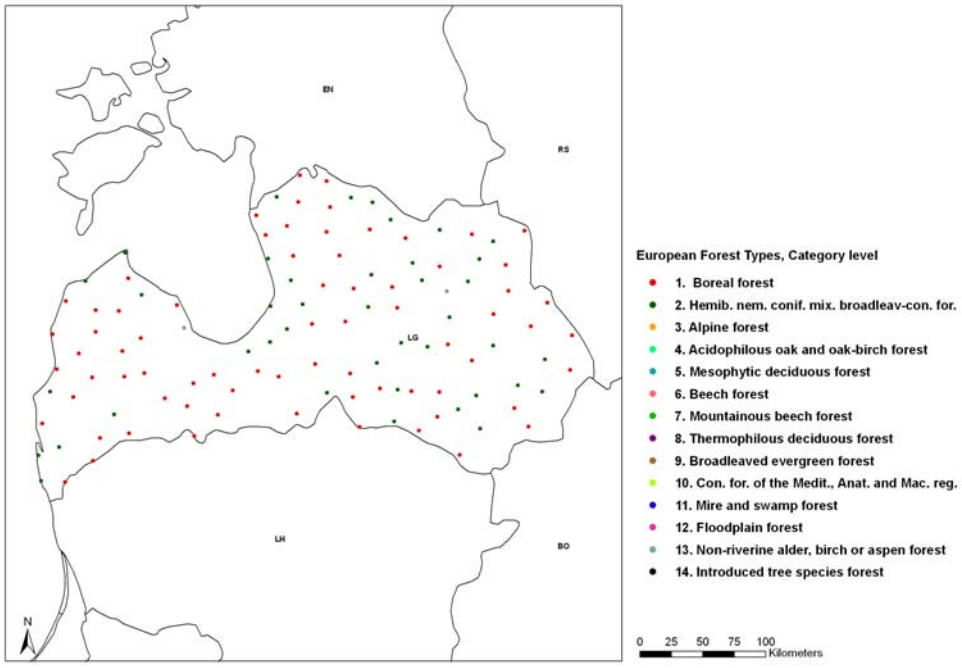


Figure 54. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.16 Lithuania

Total number of FutMon large-scale plots: 85 (Figure 55).

Relationships with existing monitoring networks: part (3) of FutMon plots were selected for the first time; the remaining plots coincide with ICP Level I plots. Information on the relationships between FutMon, NFI and Biosoil plots is missing.

Biogeographical regions: 68% of plots are in the Boreal region; 32% of plots are in the Continental region (Table 33, Figure 56).

Forest types at category level (EEA): the most part of plots are in the following categories: Boreal forest (16%); Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest (64%); Non-riverine alder, birch or aspen forest (15%) (Table 34, Figure 57).

Representativity: the total number of FutMon large-scale plots is less than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 55. Distribution of FutMon plots over forest-non forest map.

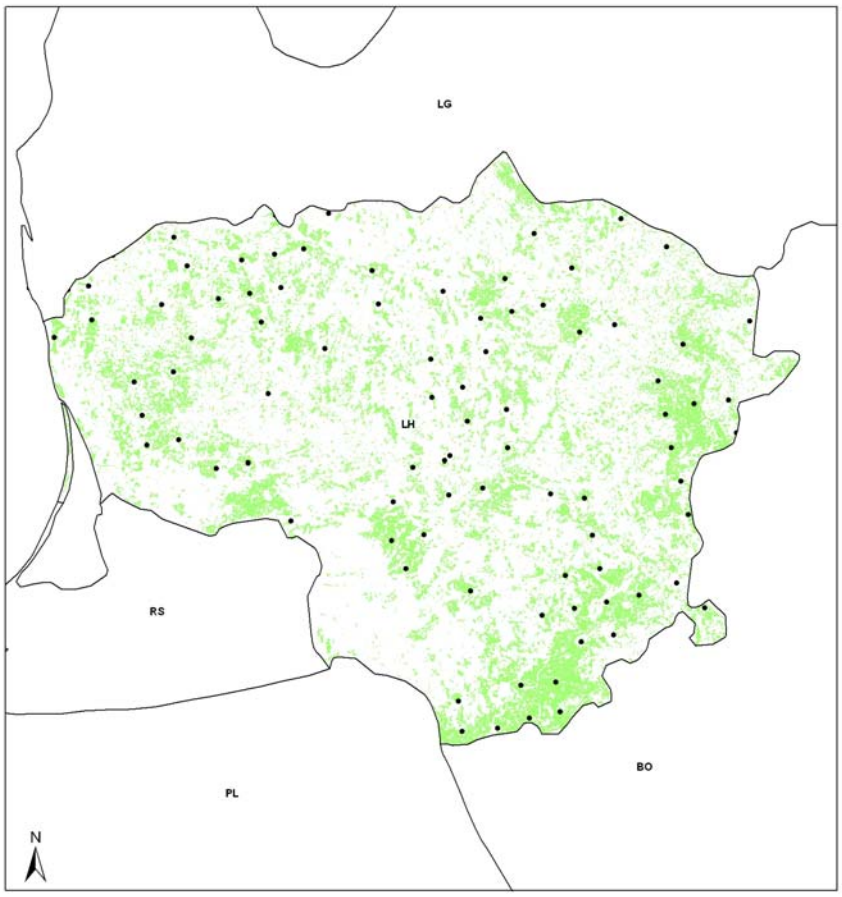


Table 33. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Lithuania	0	0	0	58	27	0	0	0	0	85

Table 34. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Lithuania	14	54	0	0	1	0	0	0	0	0	3	0	13	0	85

Figure 56. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

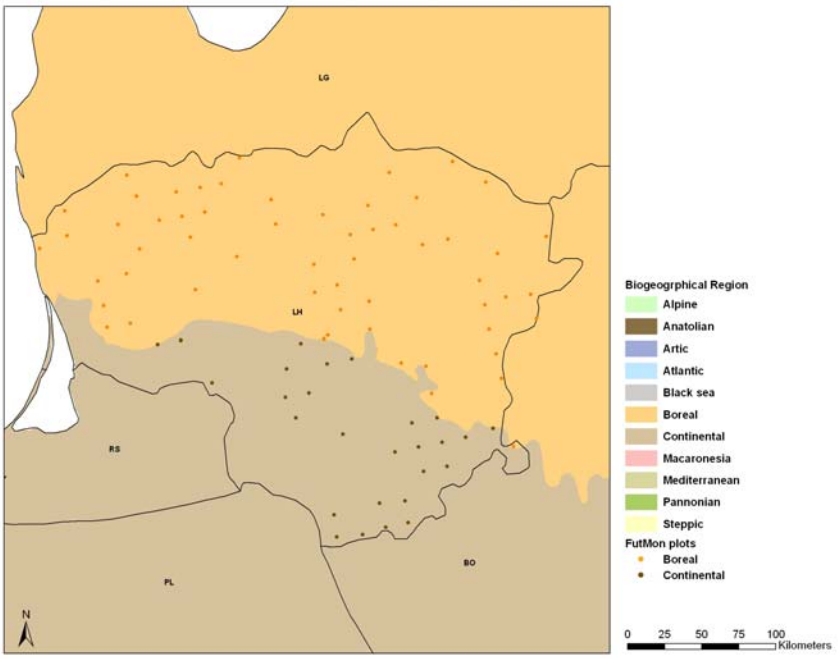
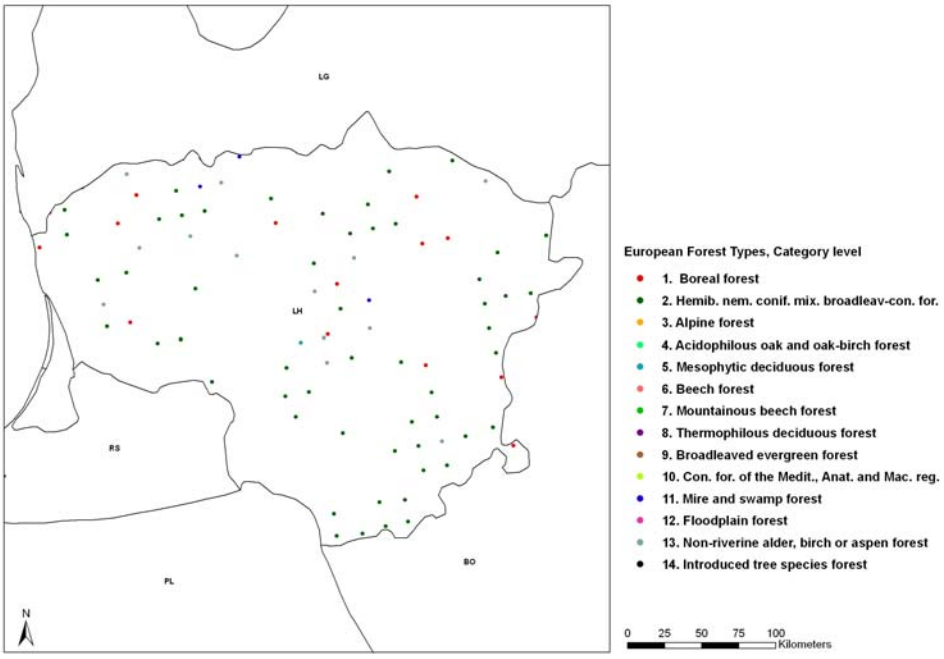


Figure 57. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.17 The Netherlands

Total number of FutMon large-scale plots: 11 (Figure 58).

Relationships with existing monitoring networks: full integration between FutMon and ICP Level I plots; no relationships between FutMon, NFI and Biosoil plots.

Biogeographical regions: all plots are in the Atlantic region (Table 35, Figure 59).

Forest types at category level (EEA): the most part of plots are in the following categories: Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest (55%); Acidophilous oak and oak-birch forest (36%) (Table 36, Figure 60).

Figure 58. Distribution of FutMon plots over forest-non forest map.

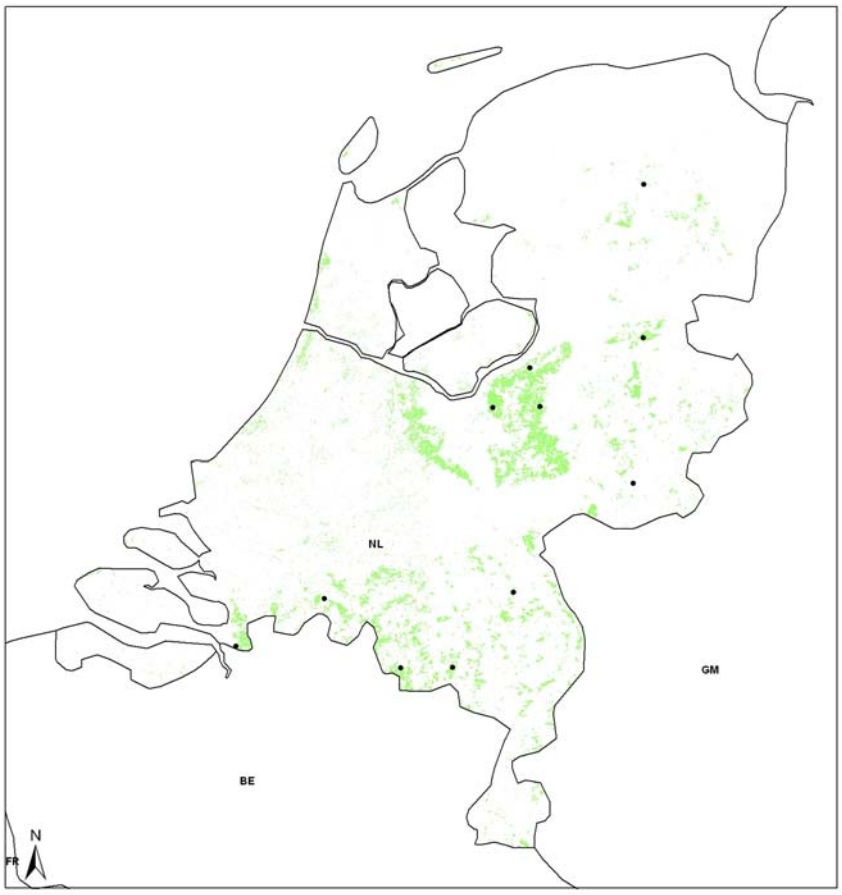


Table 35. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
The Net.	0	11	0	0	0	0	0	0	0	11

Table 36. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
The Net.	0	6	0	4	0	0	0	0	0	0	0	0	0	1	11

Figure 59. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

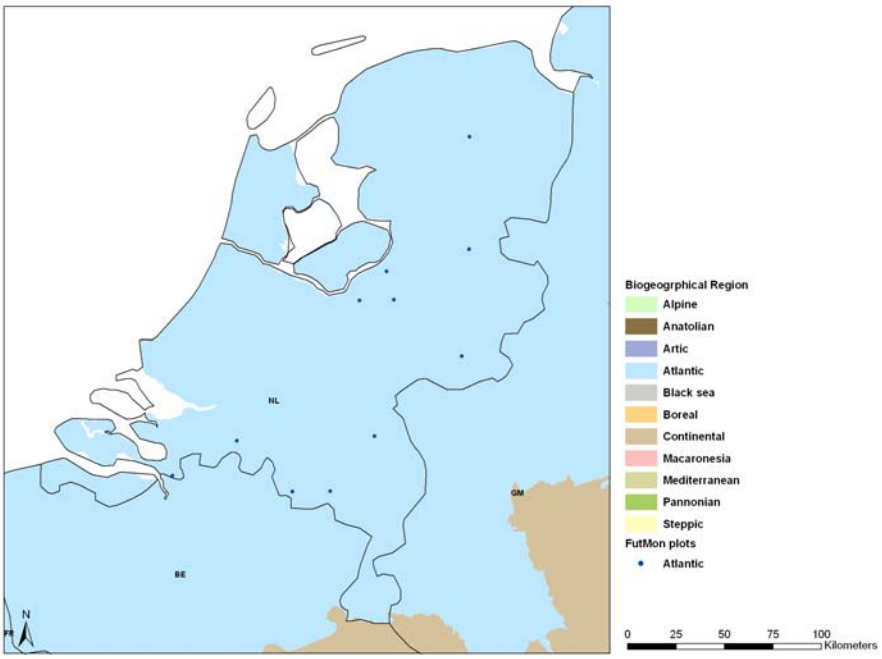
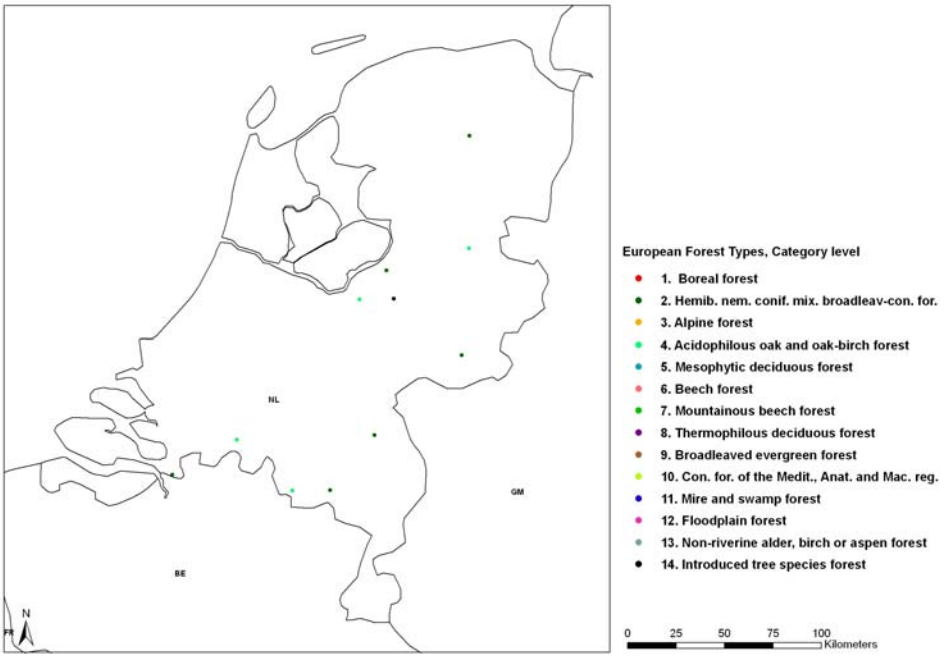


Figure 60. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.18 Poland

Total number of FutMon large-scale plots: 992 (Figure 61).

Relationships with existing monitoring networks: full integration between FutMon, ICP Level I and NFI plots. Information on the relationship between FutMon and Biosoil plots is missing.

Biogeographical regions: 94% of plots are in the Continental region; 6% of plots are in the Alpine region (Table 37, Figure 62).

Forest types at category level (EEA): the most part of plots (72%) are Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest (Table 38, Figure 63).

Representativity: the total number of FutMon large-scale plots is greater than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 61. Distribution of FutMon plots over forest-non forest map.

Table 37. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Poland	61	0	0	0	931	0	0	0	0	992

Table 38. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Poland	0	715	54	12	44	24	24	0	0	0	7	11	89	12	992

Figure 62. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

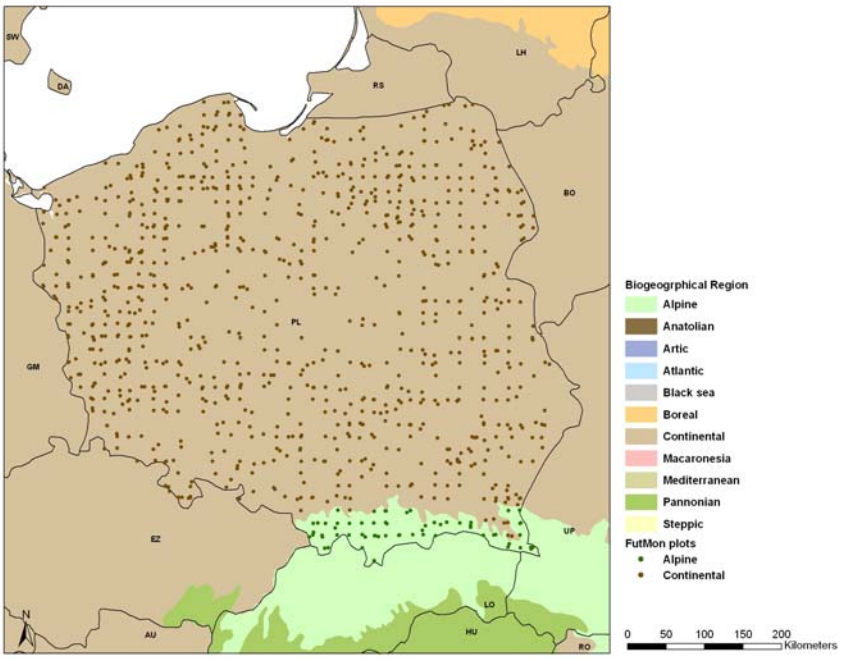
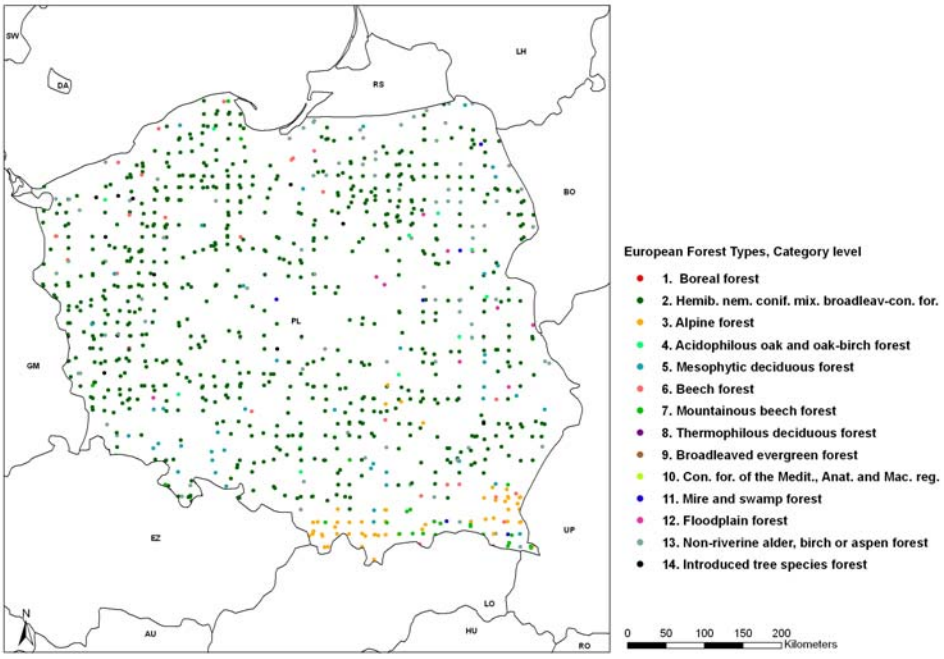


Figure 63. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.19 Romania

Total number of FutMon large-scale plots: 263 (Figure 64).

Relationships with existing monitoring networks: part (8) of FutMon plots were selected for the first time; the remaining plots coincide with ICP Level I plots. Full integration between FutMon and NFI plots. No relationship between FutMon and Biosoil plots.

Biogeographical regions: the most part of plots are in the Continental (49%) and Alpine (42%) regions (Table 39, Figure 65).

Forest types at category level (EEA): the most part of plots are in the following categories: Alpine forest (17%); Mesophytic deciduous forest (23%); Beech forest (21%); Mountainous beech forest (19%) (Table 40, Figure 66).

Figure 64. Distribution of FutMon plots over forest-non forest map.

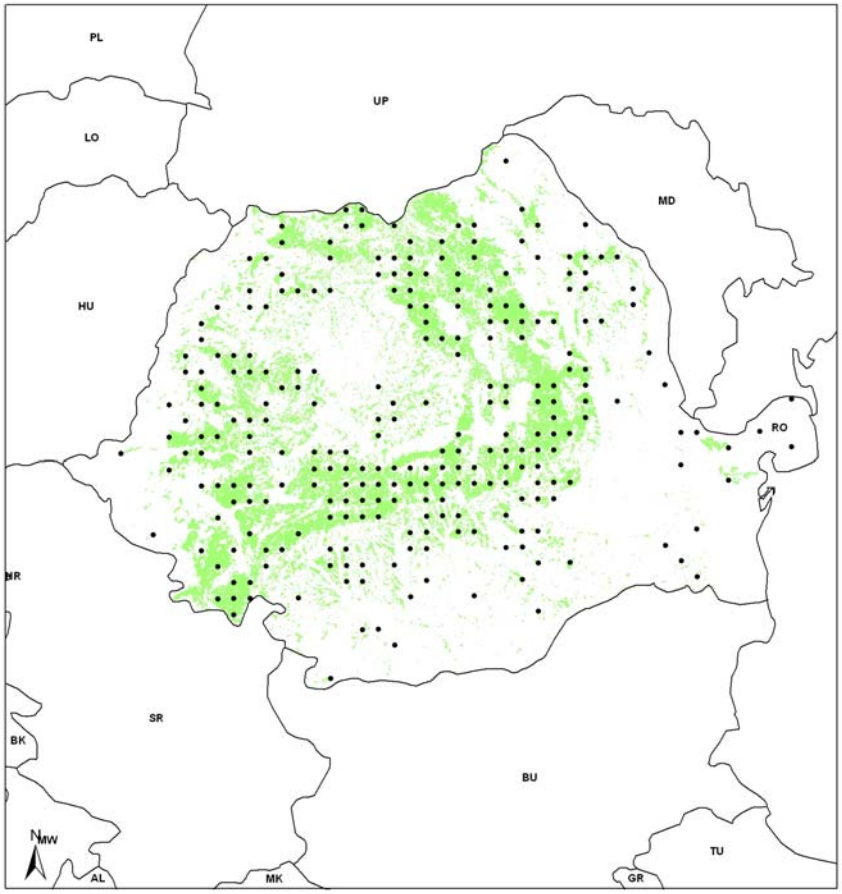


Table 39. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Romania	111	0	1	0	129	0	0	7	15	263

Table 40. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Romania	0	2	46	0	60	54	50	24	0	0	0	2	6	19	263

Figure 65. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

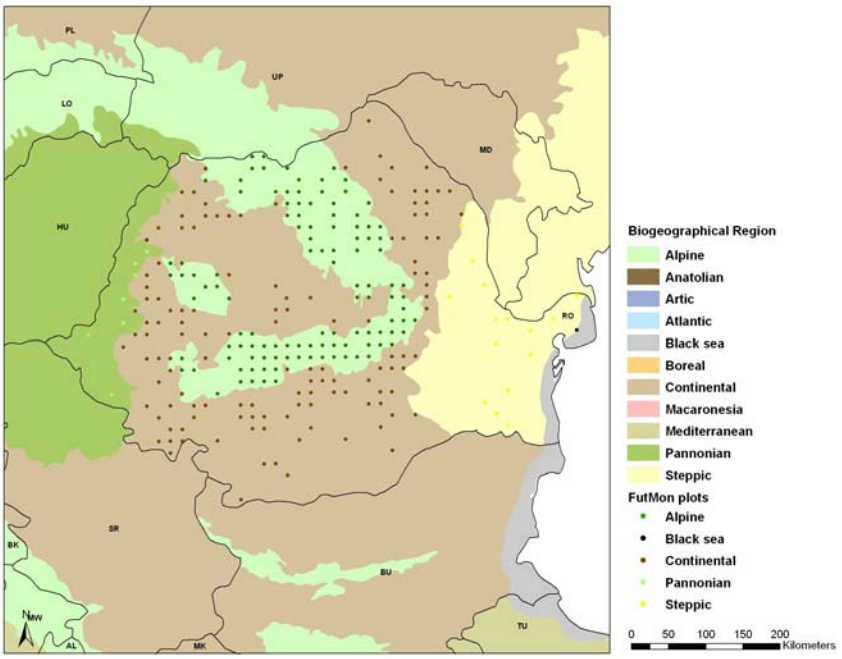
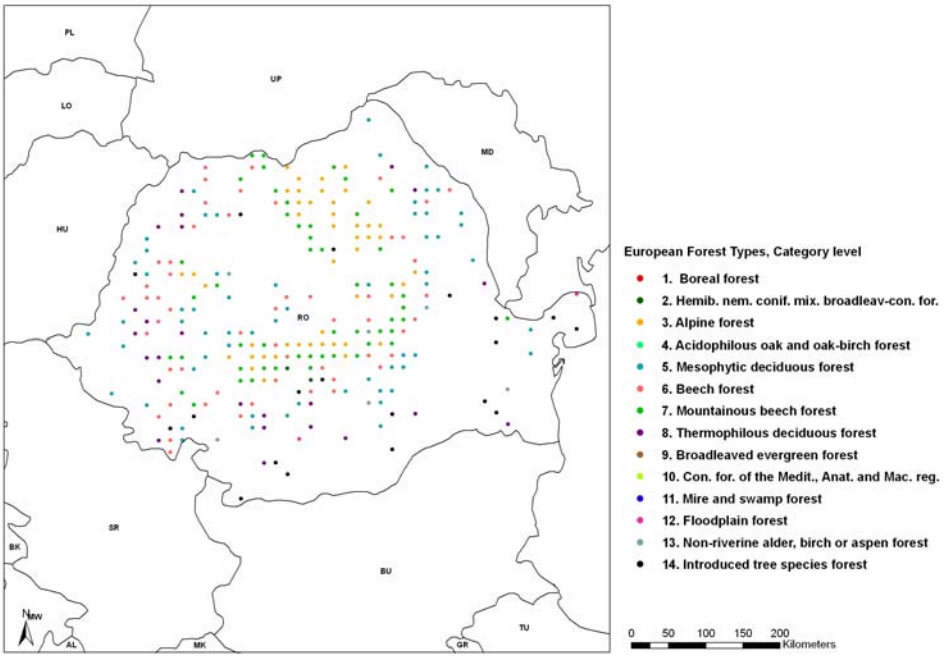


Figure 66. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.20 Slovakia

Total number of FutMon large-scale plots: 112 (Figure 67).

Relationships with existing monitoring networks: full integration between FutMon, ICP Level I and Biosoil plots. No relationship between FutMon and NFI plots.

Biogeographical regions: 79% of plots are in the Alpine region; 21% of plots are in the Pannonian region (Table 41, Figure 68).

Forest types at category level (EEA): the most part of plots are in the following categories: Alpine forest (32%); Beech forest (28%); Mountainous beech forest (13%) (Table 42, Figure 69).

Representativity: the total number of FutMon large-scale plots is greater than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 67. Distribution of FutMon plots over forest-non forest map.

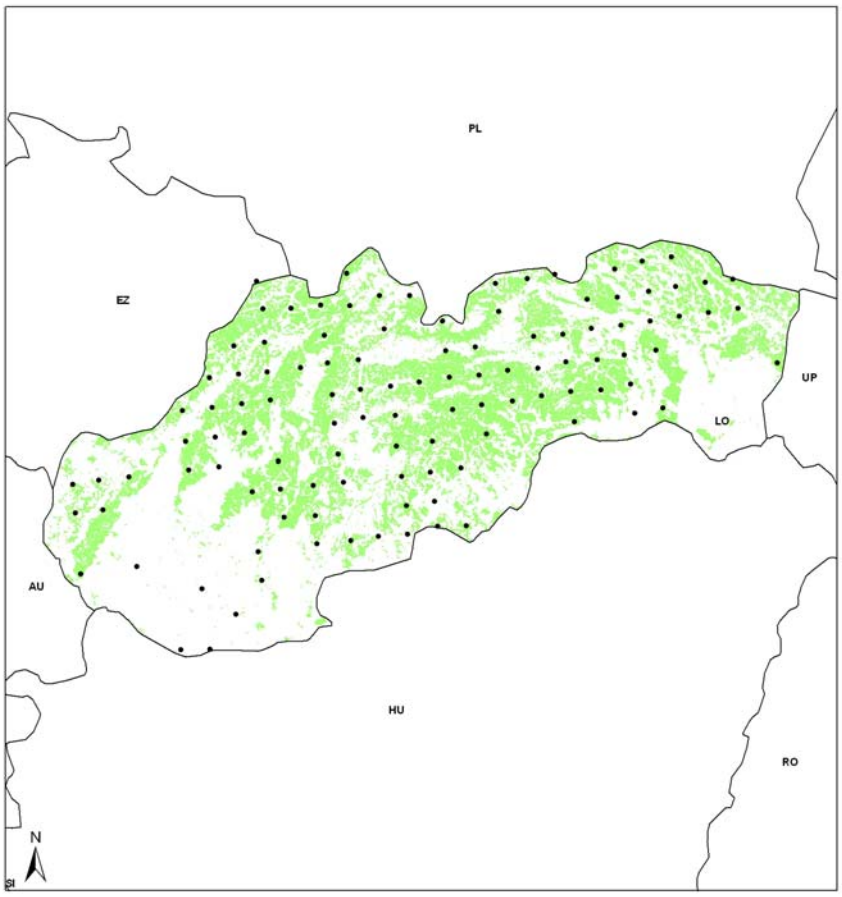


Table 41. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Slovak Rep.	89	0	0	0	0	0	0	23	0	112

Table 42. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Slovak R.	0	3	36	0	11	31	15	4	0	0	0	2	0	10	112

Figure 68. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

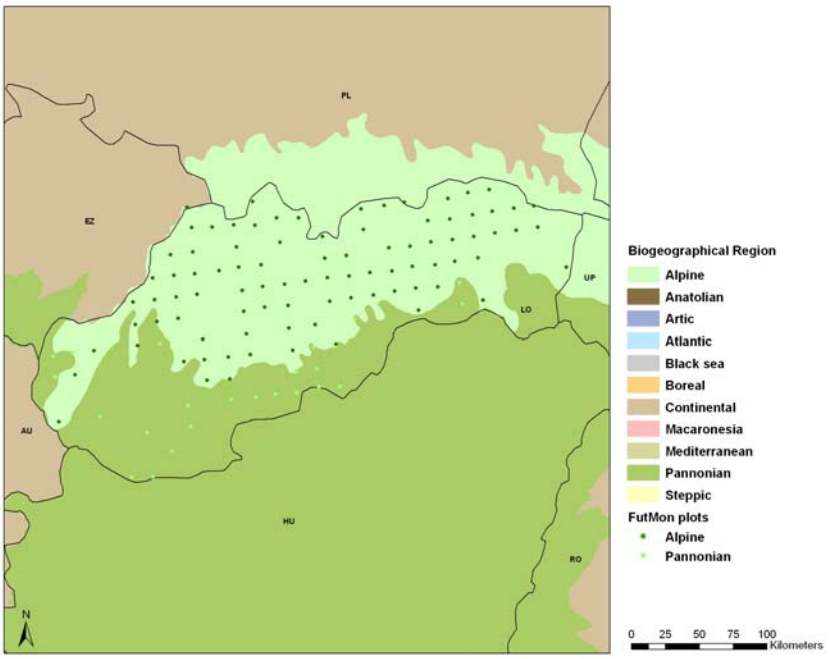
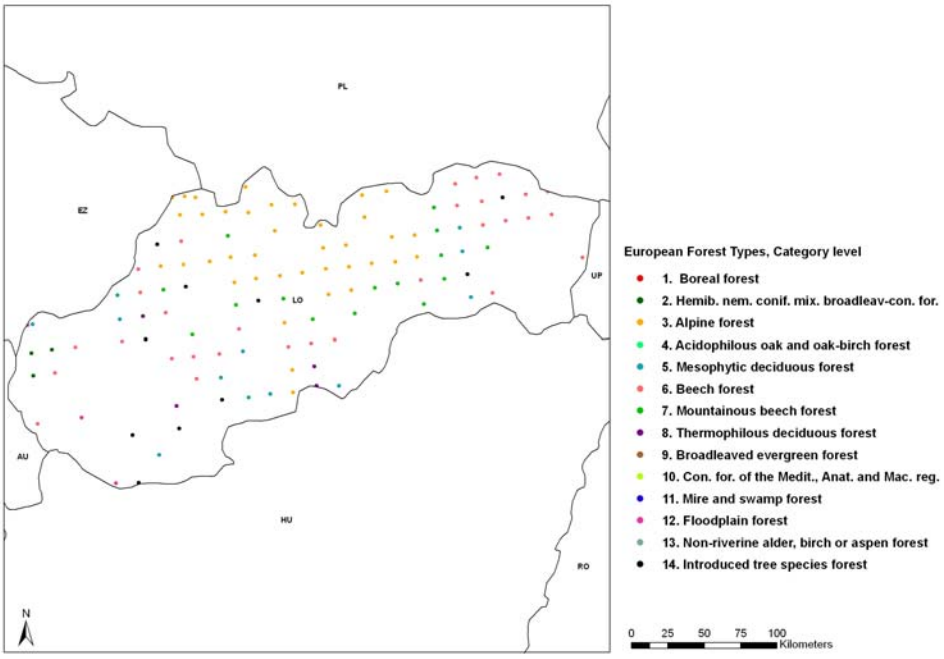


Figure 69. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.21 Slovenia

Total number of FutMon large-scale plots: 48 (Figure 70).

Relationships with existing monitoring networks: full integration between FutMon, ICP Level I and NFI plots. Information on the relationship between FutMon and Biosoil is missing.

Biogeographical regions: 69% of plots are in the Continental region; 31% of plots are in the Alpine region (Table 43, Figure 71).

Forest types at category level (EEA): the most part of plots are in the following categories: Alpine forest (21%); Beech forest (21%); Mountainous beech forest (27%) (Table 44, Figure 72).

Representativity: the total number of FutMon large-scale plots is greater than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 70. Distribution of FutMon plots over forest-non forest map.

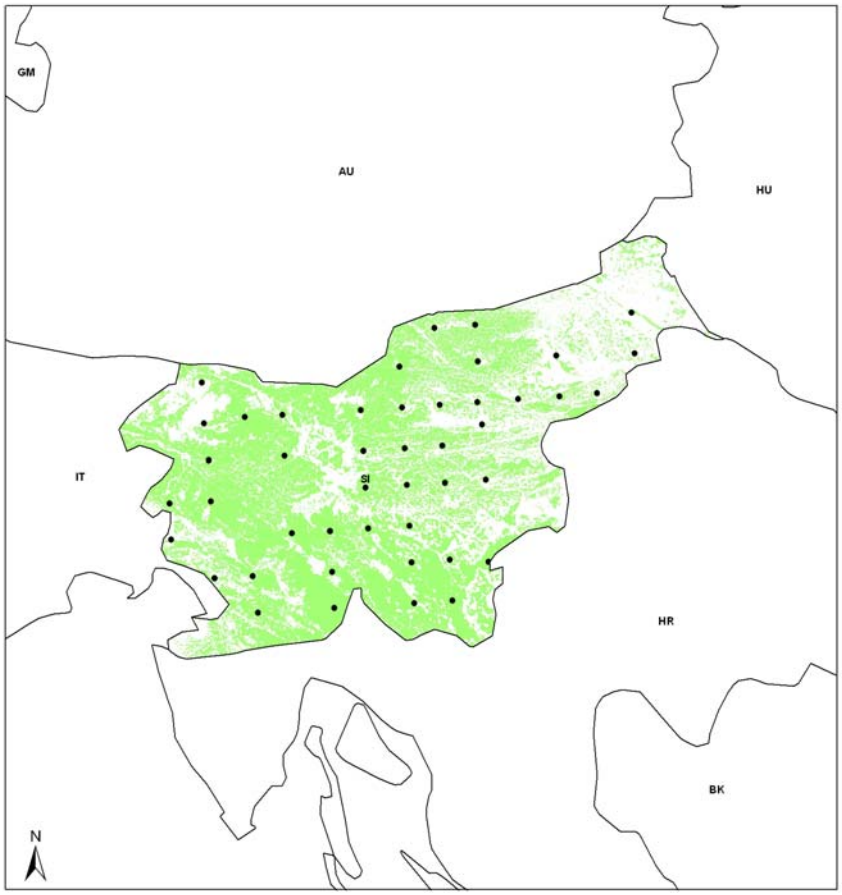


Table 43. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Slovenia	15	0	0	0	33	0	0	0	0	48

Table 44. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Slovenia	0	5	10	0	3	10	13	2	0	0	0	1	1	3	48

Figure 71. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

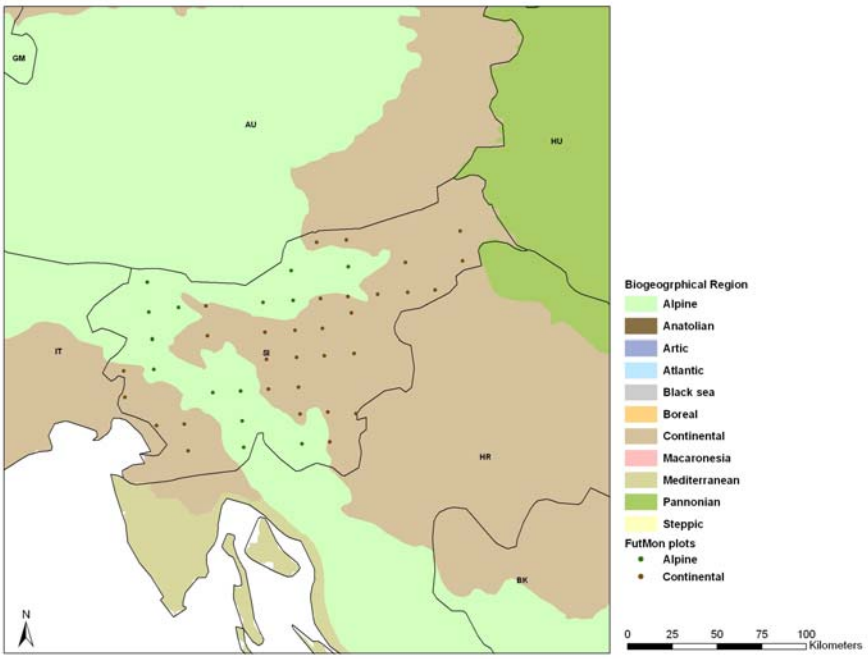
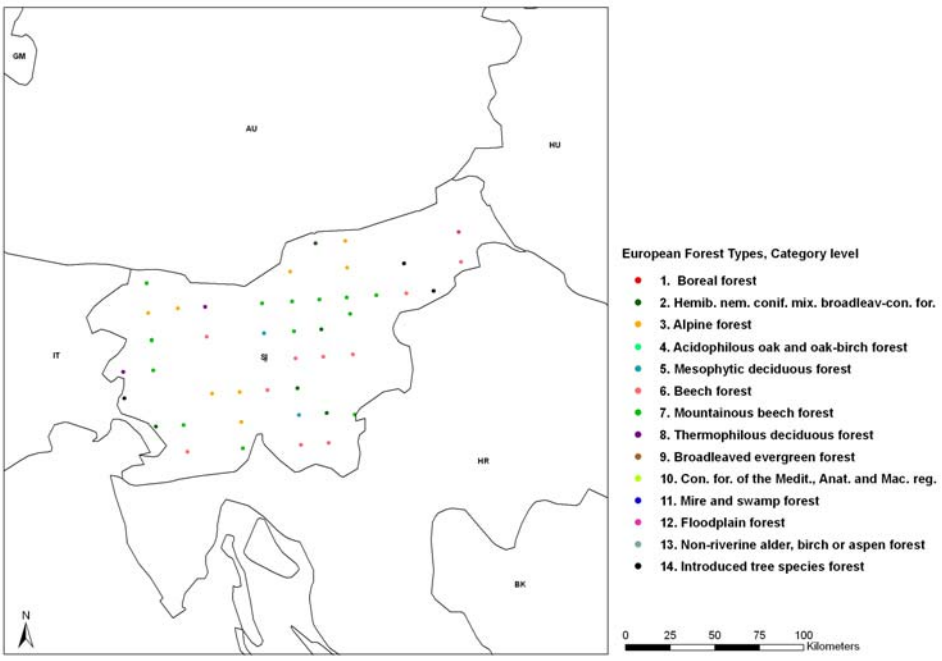


Figure 72. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.22 Spain

Total number of FutMon large-scale plots: 696 (Figure 73).

Relationships with existing monitoring networks: full integration between FutMon, ICP Level I and Biosoil plots. No relationship between FutMon and NFI plots.

Biogeographical regions: the most part of plots are in the Mediterranean (79%) and Atlantic (15%) regions (Table 45, Figure 74).

Forest types at category level (EEA): the most part of plots are in the following categories: Broadleaved evergreen forest (30%); Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions (41%) (Table 46, Figure 75).

Representativity: the total number of FutMon large-scale plots is greater than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 73. Distribution of FutMon plots over forest-non forest map.

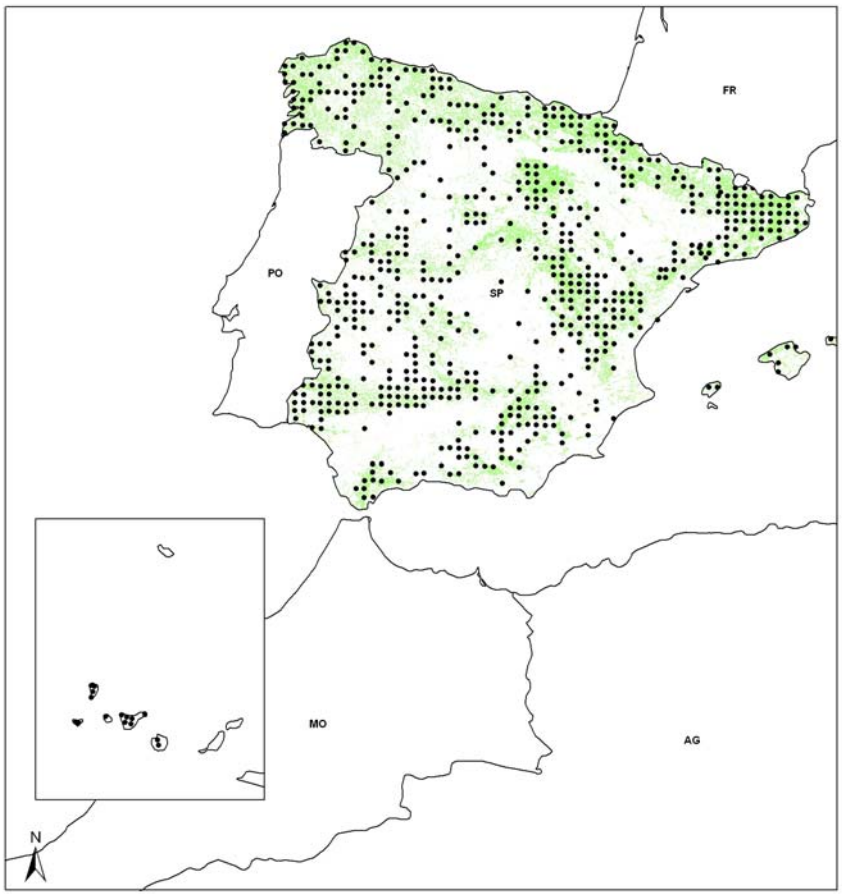


Table 45. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Spain	25	107	0	0	0	15	549	0	0	696

Table 46. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Spain	0	0	16	10	11	3	14	64	211	283	0	5	3	76	696

Figure 74. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

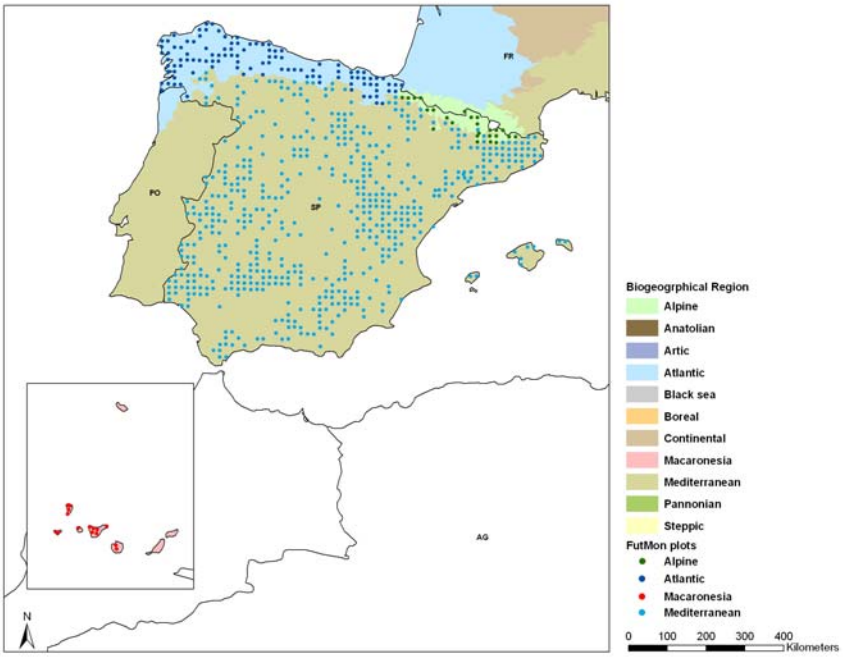
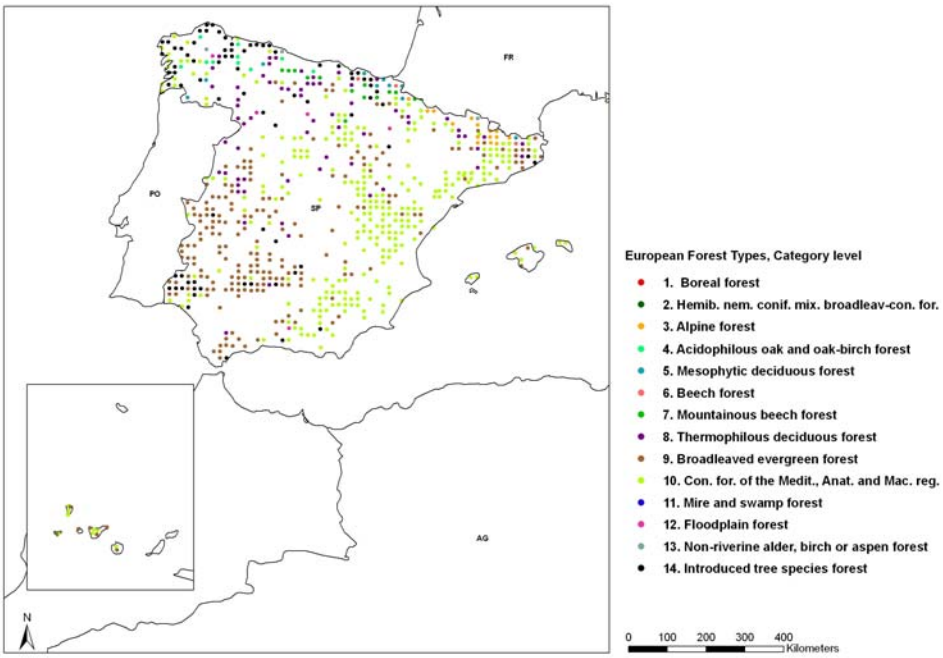


Figure 75. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.23 Sweden

Total number of FutMon large-scale plots: 857 (Figure 76).

Relationships with existing monitoring networks: full integration between FutMon, ICP Forest Level I and NFI plots. No relationship between FutMon and Biosoil plots.

Biogeographical regions: the most part of plots are in the Boreal region (Table 47, Figure 77).

Forest types at category level (EEA): the most part of plots are in the following categories: Boreal forest (71%); Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest (23%) (Table 48, Figure 78).

Representativity: the total number of FutMon large-scale plots is less than sampling effort required for achieving a percentage standard error of 5% (see Table 1a).

Figure 76. Distribution of FutMon plots over forest-non forest map.

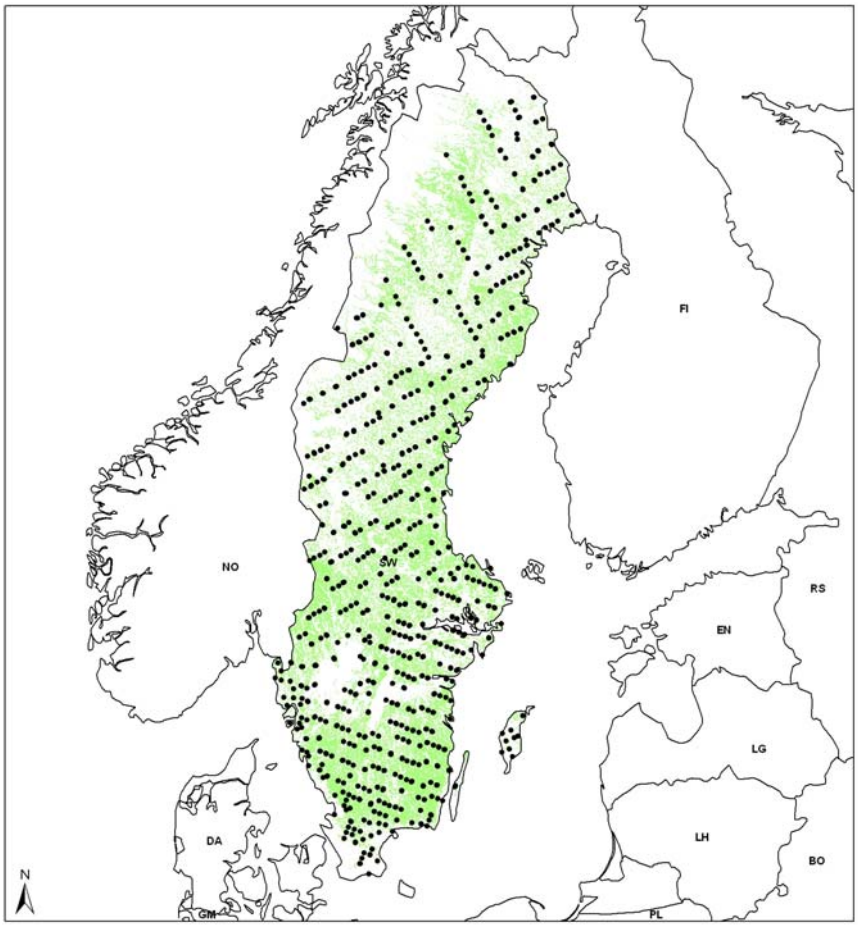


Table 47. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
Sweden	63	0	0	755	39	0	0	0	0	857

Table 48. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
Sweden	611	194	0	1	4	6	0	0	0	0	0	0	30	11	857

Figure 77. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

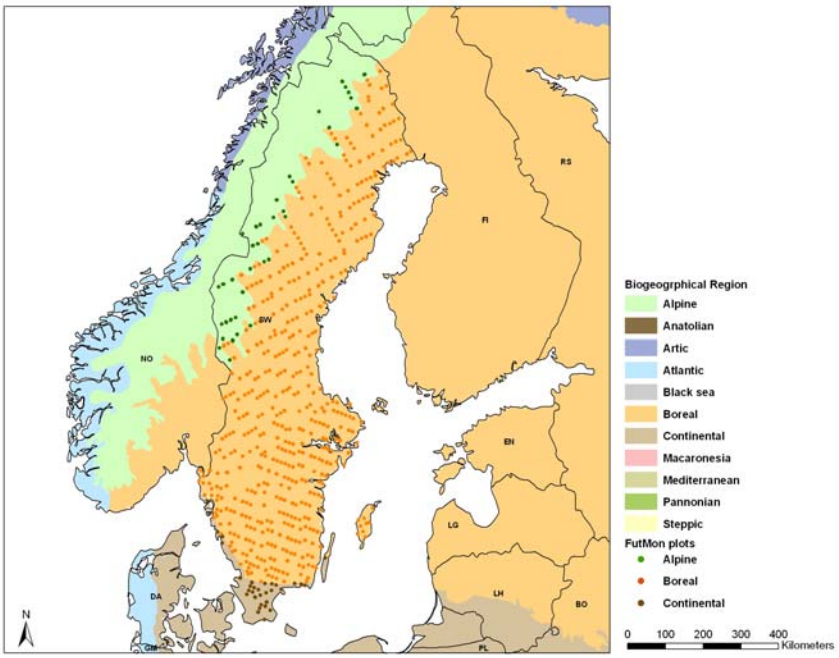
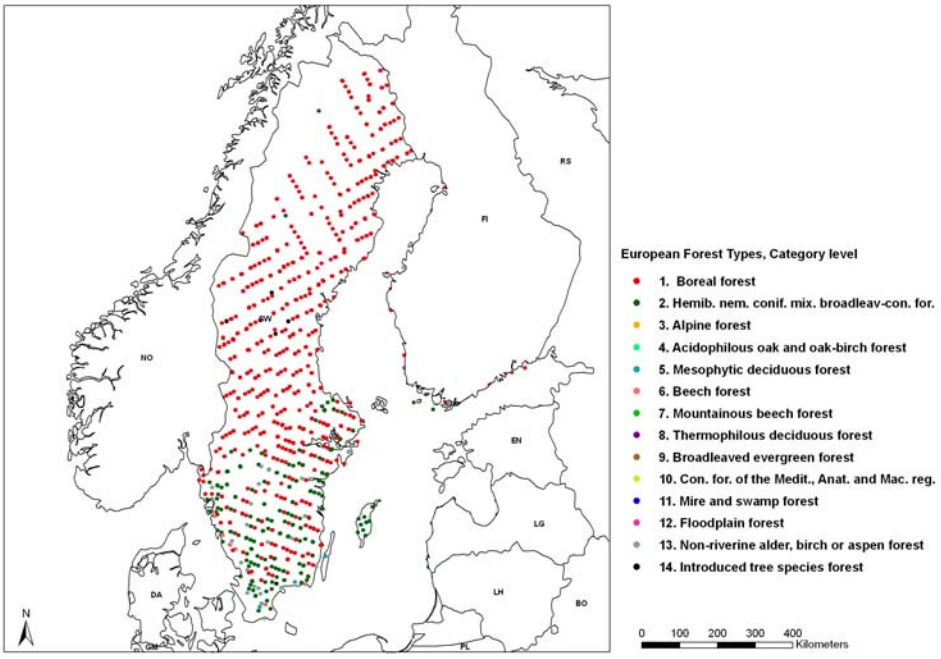


Figure 78. FutMon large-scale plot labeled with different colors representing the EFT at category level.



4.3.24 United Kingdom

Total number of FutMon large-scale plots: 105 (Figure 79).

Relationships with existing monitoring networks: full integration between FutMon, ICP Level I and NFI plots. Information on the relationship between FutMon and Biosoil plots is missing.

Biogeographical regions: all plots are in the Atlantic region (Table 49, Figure 80).

Forest types at category level (EEA): the most part of plots are in the following categories: Mesophytic deciduous forest (13%); Introduced tree species forest (69%) (Table 50, Figure 81).

Figure 79. Distribution of FutMon plots over forest-non forest map.

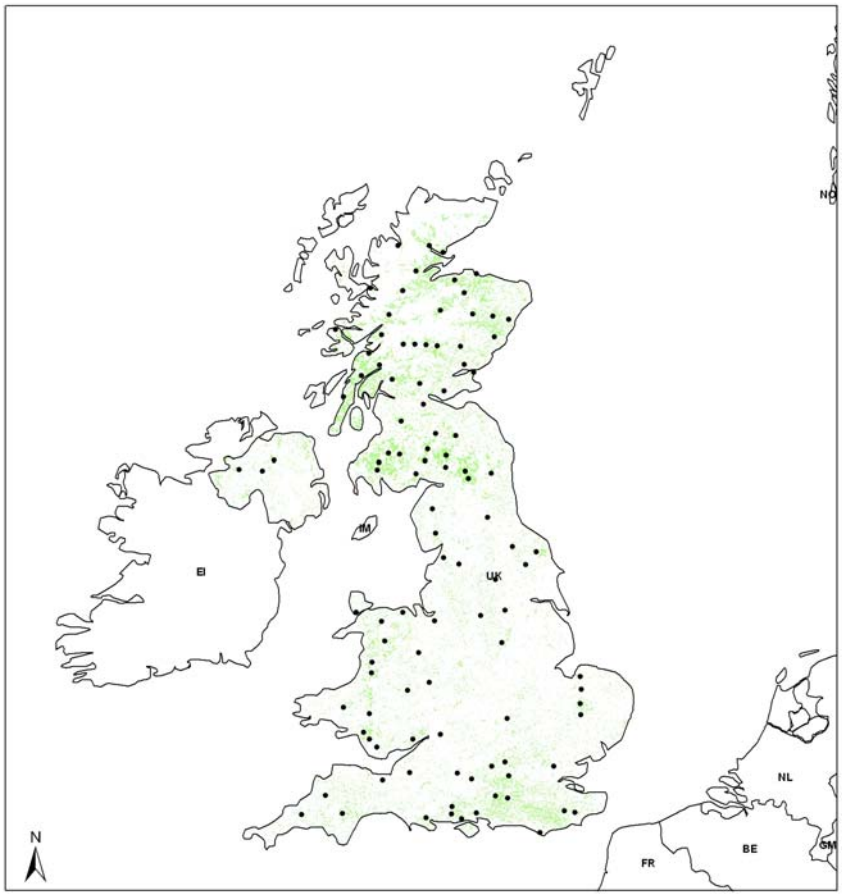


Table 49. Number of FutMon plot in each Biogeographical region.

Country	Alpine	Atlantic	Black sea	Boreal	Continental	Macaronesia	Mediterranean	Pannonian	Steppic	Total
UK	0	105	0	0	0	0	0	0	0	105

Table 50. Number of FutMon plot in each EFT at category level (see Table 2: 1. Boreal forest; 2. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest; 3. Alpine forest; 4. Acidophilous oak and oak-birch forest; 5. Mesophytic deciduous forest; 6. Beech forest; 7. Mountainous beech forest; 8. Thermophilous deciduous forest; 9. Broadleaved evergreen forest; 10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions; 11. Mire and swamp forest; 12. Floodplain forest; 13. Non-riverine alder, birch or aspen forest; 14. Introduced tree species forest).

Country	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Tot.
UK	0	3	0	3	14	12	0	0	0	0	0	1	0	72	105

Figure 80. FutMon large-scale plot labeled with different colors representing the Biogeographical regions.

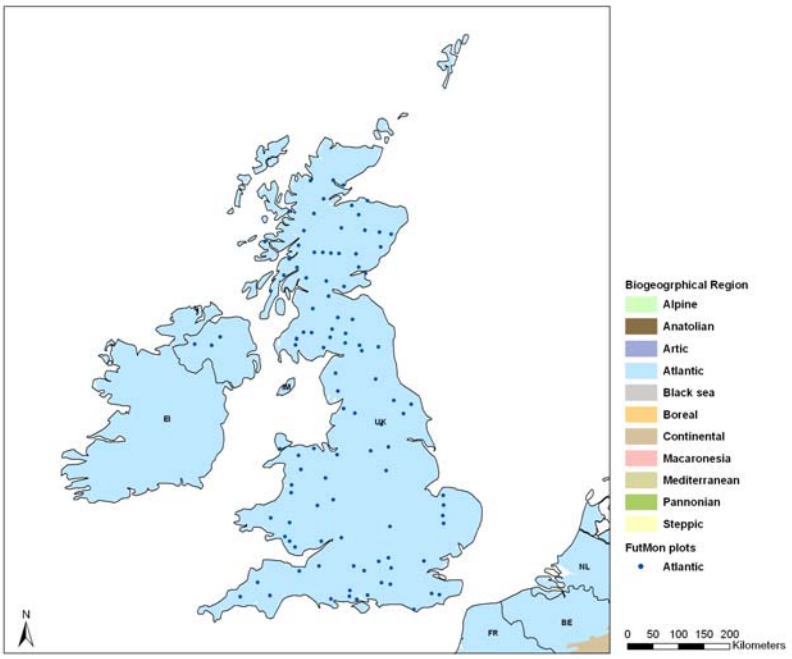
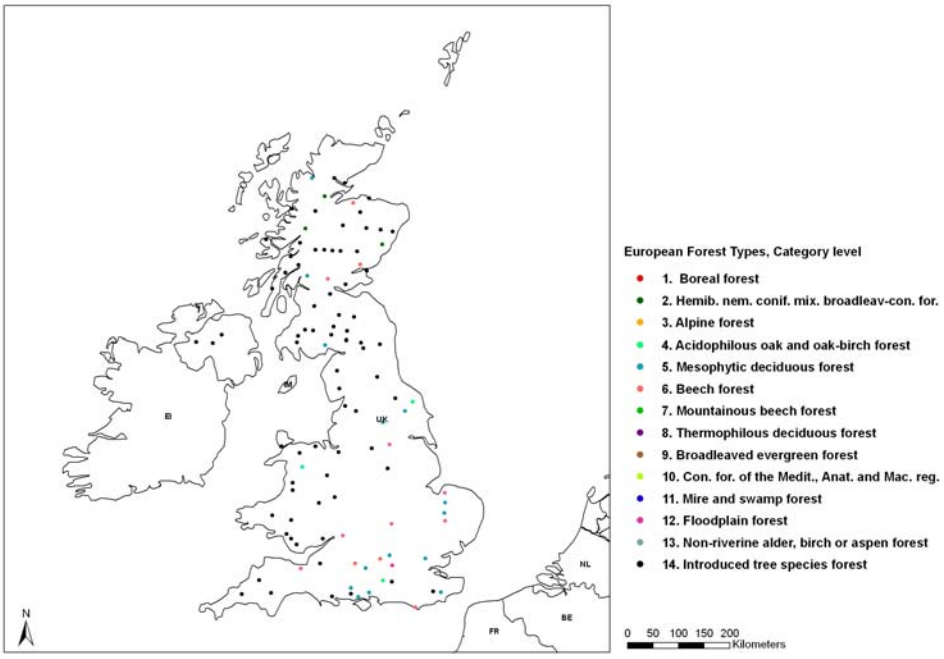


Figure 81. FutMon large-scale plot labeled with different colors representing the EFT at category level.



5 Discussion and conclusions

Extensive and comprehensive data on status and changes of European forests are requested for international reporting. NFIs and FCM networks are primary source of data for large area assessment of forest resources. However, at present neither NFIs nor current FCM systems are able to produce unbiased estimates of forest attributes at European level.

A forest monitoring system based on probabilistic sampling has been proposed within the Action C1 HarmonLS of FutMon project to produce statistically sound estimates of forest condition parameters in Europe. Under the assumption of a common definition of forest among European countries, a formal definition of monitoring objectives, parameters of concern and accuracy standards for assessing their status and changes has been suggested for the first time. Fixed-area plot approach has been proposed as unifying scheme to sample trees which, at the same time, allows difference among European countries according to their necessities. Statistical estimators have been developed to produce forest condition parameters estimation at country and at European levels. Estimations at European level are based on two alternative strategies: the combination of FCM estimates or the aggregation from FCM and NFI estimates (Diagram 1). The success of a FCM program rests on its ability to provide quantitative estimates of the condition attribute of interest at specified level of accuracy and its ability to detect changes between years. At least to our knowledge, this proposal constitutes the first attempt to state the characteristics of a monitoring system at country and European levels.

The FAO FRA definition of forest (UNECE-FAO, 2000) is a reference standard recognized at international level. In Europe this definition is used by countries as the basis for their national definitions of forest (e.g., Finland, Denmark, Italy) or as a definition towards which their definitions will migrate (Tomppo et al., 2010).

However, because of the diversity of national definitions, sampling design, plot configurations, measured variables and measurements protocols, harmonization processes are needed to obtain compatible estimates among different countries (Winter et al., 2008; McRoberts et al., 2009; Tomppo et al., 2010; Chirici et al., 2011). Researchers are thus focusing their efforts on the development of the so called bridging functions, which are methods aimed at converting estimates based on national definitions to estimates based on reference definitions (Rondeux et al., 2010, in review; Ståhl et al., 2010, in review).

With reference to the proposal for a forest monitoring system based on probabilistic sampling, bridges might be applied when combining independent country estimates at European level to obtain forest condition parameters harmonized to reference definition.

Guidelines and practical suggestions towards an harmonized system between FCM and NFI networks have been drawn for the following cases (Ferretti, 2010): a) FCM and NFI are already on the same network; b) FCM and NFI are carried out on separate networks. In the former case harmonization exists at national level even if some further harmonization may be necessary to adapt national definitions to international one using bridging functions. In the latter case, three scenarios have been proposed to get integration between networks: 1) Harmonization of methods; 2) Functional integration of networks; 3) Full integration of networks.

On these bases the criteria for the location of the FutMon large-scale plots have been developed by Action C1 HarmonLS. The criteria have been used by Associated beneficiaries to select their own plots.

The coordinates of the plots have been used within the Action C1 HarmonLS to create the EU geographical database of the FutMon large-scale monitoring system. For each plot the database has been compiled with the following data: i) location; ii) relationship with existing monitoring schemes (ICP Forests/BIOSOIL, national forest inventories); iii) biogeographical region; iv) forest types following the classification of the European Environment Agency at category level.

A total of 6941 plots have been included within the FutMon large-scale monitoring system. The original ICP Forests Level I grid has been revised by Associated beneficiaries so that as many FutMon plots as possible coincide with National Forest Inventory plots. In most of the Countries the total number of FutMon plots is greater than the sampling effort required for estimating the proportion of defoliated trees greater than 25% with a percentage standard error of 5%.

6 References

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