ANNEX 3

Other detailed methodological descriptions for LULUCF:

1. National forest inventory 2007 (NFI 2007)
2. National forest inventory 2012 (NFI 2012)
3. Information relating to Cropland Management, Grazing Land Management, Revegetation and Wetland Drainage and Rewetting

1 National Forest Inventory 2007 (NFI 2007)

Methodology

When designing NFI 2007 for KP/UNFCCC reporting purposes, recommendations of GPG 2003 and COST Action E43 have been considered as far as possible. If NFI will be repeated in five years time (in the year 2012). its design and methodology will offer reliable data sets about volume of wood growing stock; state, changes (increment, felling) – development/trends – of all Slovenian forests.

Convention on long range transboundary air-pollution (UN/ECE 1979) presents the legislative framework for ICP monitoring scheme - Assessment and Monitoring of Air Pollution Effects on Forests (FCS - inventory in the year 2000). FCS as it is defined in Official Journal of the Republic of Slovenia (Official Journal of the RS, nr. 92/00, 56/06), presents basis for development of Slovenian national forest inventory 2007 (NFI 2007) design.

Assessment methodology is supplemented according to the findings of test inventory, which was carried out in the year 2006 on 43 sample plots (16 x 16 km sampling grid). NFI 2007 was performed on 778 sample plots in forests, organized by 4 x 4 km sample grid which covers the whole Slovenian territory

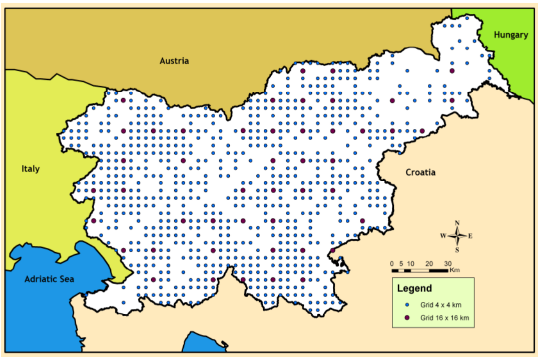

Figure 1: Arrangement of NFI 2007 sample plots on 4 x 4 km sample grid (●) and 16 x 16 km sample grid (●)

Arrangement of NFI 2007 sample plots principally remained the same as in the inventory in the year 2000 – FCS. Basic sample unit plot of NFI 2007 is CPP As written before the CPP is spatially identified by the geographical coordinates of the centre of the CPP, which is positioned 50 meters west from the base sample grid section (integer number of coordinates). Neither plots nor trees are visually marked with numbers, letters etc., so the inventory results and data remain representative due to unbiased forest management practice carried on in stands with sampling plots. Statistically, the NFI 2007 was characterized as a systematically single stage sampling.

Due to changes in FCS protocols and additional field data that were obtained, the design of CPP (2007) was changed in respect to the design of inventory in the year 2000. Inner concentric plot for volume of growing stock of small trees ($D_{1.3}$ > 0 cm) assessment was added. Basic characteristics for all 4 concentric plots which CPP is composed of are shown in Figure 2.

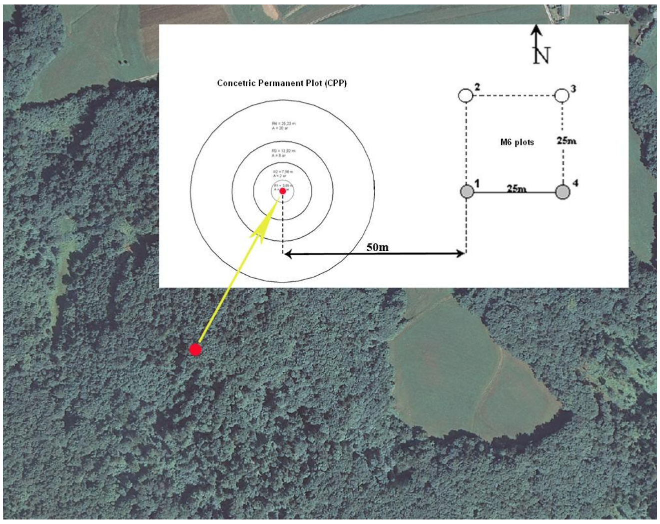

Figure 2: Scheme of CPP (on 16 x 16 km grid – CPP + all four M6 plots; on 4 x 4 grid – CPP + M6 plots nr. 1 and 4)

Table 1: Critical values for assessing living and dead tree wood stock on CPP in NFI 2007

Plots	CPP_1	CPP_2	CPP_3	CPP_4
Radius (R) of the plots [m]*	3.09	7.98	13.82	25.23
Area (P) of the plots [ar]	0.3	2	6	20
Characteristics of stand and site	Area of 20 ar			
Standing live trees	$D_{1.3} > 0$ cm $H \geq 1.3$ m	$D_{1.3} \geq 10$ cm	$D_{1.3} \geq 30$ cm	/
Standing dead trees	$D_{1.3} \geq 10$ cm		$D_{1.3} \geq 30$ cm	
Lying dead trees	$D_{1.3} \geq 10$ cm		$D_{1.3} \geq 30$ cm	
Stumps	$D \geq 10$ cm $H \geq 20$ cm		/	
Snags	$D \geq 10$ cm $H \geq 50$ cm		$D \geq 30$ cm $H \geq 50$ cm	
Coarse woody debris – woody parts of trees (branches, parts of stem etc.)	$D \geq 10$ cm $L \geq 50$ cm		$D \geq 30$ cm $L \geq 50$ cm	

*Reduction of plot area regarding to terrain slope should be considered when defining radius of the plots!

Field work and assessment on CPP

Field work – measurements and assessment – on CPP in NFI 2007 consists of:

- detailed description of the plot (assessment of the site and stand),
- measurements and assessment of trees (diameter/circumference at breast height, distance and azimuth from the plot's centre to every measurable tree, tree species, social/height class, defoliation, height and age of the three thickest trees, tree status regarding to type of growing stock/biomass (living, dead, standing, lying), tree status code – present in both assessments (in the years 2000 and 2007), cut down/felling, dead etc.),
- measurements and assessment of dead wood (type of dead wood, diameter and length /height, tree species, decay class).

Dead wood assessment

Dead trees (fallen or still standing) are measured regardless of bark being present or not. Lying dead trees are measured if their diameter at breast height ($D_{1.3}$ – from the beginning of a stem) lies inside of a critical plot radius and is bigger or equal 30 cm (see examples 1. 2 and 3). Dead tree still has to have branches, so it can be recognised as a tree. If branches are no longer attached to a tree, it is treated as a large wooden piece. If a larger wooden piece lies on plot partially (example 5), only the part inside the critical radius is taken into consideration (length (L) and mean diameter (D) are measured). All critical values from the are also considered.

Stump is measured if its centre (see example 6) is within the critical plot radius. Furthermore the following has to be considered:

- for stumps which lay on slope terrain or are of different shapes, upper and lower height is measured and mean value of the height (H) is calculated. Mean diameter (D) is also calculated for the bigger and smaller diameter,
- where roots were pulled out from soil, or if they grew above litter level, only stump without roots is measured.

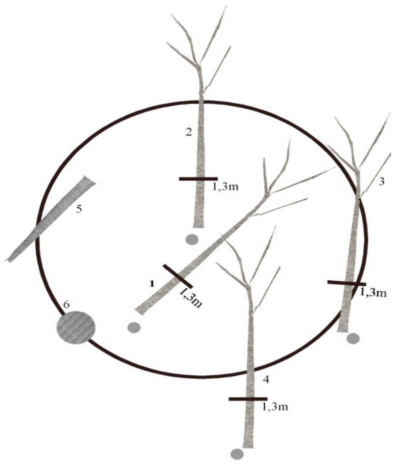

Figure 3: Examples of laying dead trees and stumps

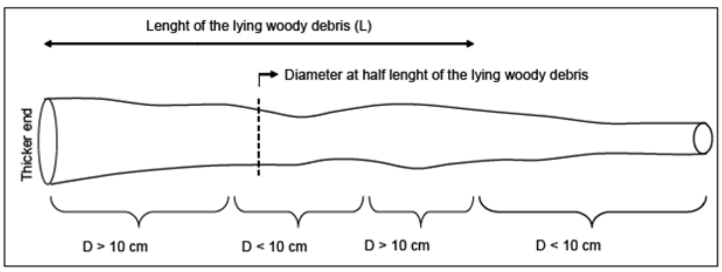

Figure 4: Example of a larger deadwood piece (length is measured from the thicker end to the thinnest end with D ≥ 10 cm)

Basic information about NFI 2007

Slovenian Forestry Institute (SFI) had lead the activities of NFI 2007 but the field work had been carried out mostly by the field crews composed of Slovenia Forest Service (SFS) staff and students.

Characteristics of NFI 2007 are:
- sample grid 4 x 4 km, 778 circular permanent plots (CPP),
- field work performed: July and August 2007,
- 35 field crews of SFS (inventory on plots on 4 x 4 km grid),
- 3 field crews of SFI (inventory on plots on 16 x 16 km grid, training of SFS field crews, control check and quality assurance – on 5 % of all plots),
- field crew mainly consists of one leader (university forest engineer) and one unskilled assistant (student).

Basic field crew equipment:
- handy GPS device for satellite navigation,
- measurement tape for diameter/circumference and distance measuring,
- diameter calliper,
- compass with stand-pole,
- Vertex instrument,
- tree height measurement instrument,
- inclinometer,
- field manual, data entry forms, code sheets, plot access maps.

Description of work in NFI 2007

Activities in NFI 2007 were carried out in following order:
- NFI 2007 field protocol preparation:
    - study of international protocols and requirements (KP, GPG 2003, COST E43) and harmonization of their demands (basis was the inventory performed in the year 2000),
    - harmonization of data sets which were later obtained in field between SFS, Ministry of agriculture, forestry and food (MAFF) and Ministry of the Environment and Spatial planning (MESP) (agreement on the set of field data, field crews, financing, equipment etc.),
    - defining of NFI 2007 concept (statistical design, sample grid, standards of quality and measurements, area of plots, algorithms etc.),
    - final edition of the NFI 2007 field protocol.
- Preparation of plot access information and data entry forms:
    - setting of spatial information system with all available information layers (topography, digital ortho-photo, theoretical plot coordinates, land use data for the year 2000 by the MAFF – forest/non-forest land etc.),
    - spatial control if all existing CPP are inside forests and adding of new plots regarding to land use data (MAFF),
    - preparation of the assessment data from the inventory in the year 2000 and printing data entry forms with data from the year 2000,
    - field testing of the protocol (plot access map, data entry forms, protocol, equipment etc.),
    - preparation and printing of data entry forms (stand, plot, trees, small living trees, dead wood),
    - preparation and printing of plot access information (maps and description of

    - access),
    - preparation and printing of code sheets (stand, plot, trees, small living trees, dead wood),
    - printing of NFI 2007 field protocol,
    - equipment purchase (examination and completion of equipment for SFI and SFS).
- Course and training for SFI and SFS field crews
    - preparation of the field crews list (SFI and SFS), course attendance for field workers in June was obligatory,
    - preparation of the programme and realization of the 4-day course and training (19.-22.6.2007. 50 attendees).
- Field measurements:
    - introducing SFS field crews into *in-situ* field work: 3 SFI field crews had visited each one of SFS field crews at the beginning of work and carried out the complete protocol of assessment in at least one of the plots,
    - field assessment on 760 plots of 4 x 4 km grid (35 SFS field crews),
    - field assessment on 40 plots of 16 x 16 km grid (3 SFI field crews),
    - resolving of actual problems that appeared on field assessments,
    - re-measurement for quality control purposes: 3 SFI field crews (5 % or 40 plots).
- Data entry:
    - preparation of FoxPro forms for entering data into NFI 2007 data base,
    - preparation of data entry manuals and short training course of data entry staff (4 students),
    - data entry and on-line control of data entry process.
- Data processing:
    - manual and logical checks of all entered data are carried out,
    - preparation of algorithms and programs for data calculation (volume of wood growing stock calculation, increment, volume of dead wood stock),
    - the final thorough quality check, data processing and preliminary results.
- Data management:
    - Plot's access maps, data entry forms (filled) and NFI 2007 data base had been in physical and in digital forms archived. Security back-up of all NFI 2007 data base, which is located on SFI server, is made on regular basis.

Quality assurance

All field crews had to attend training course where field measurement protocol was exhaustively presented. When actual field work started. SFI crews visited each SFS crew and carried out the whole procedure side by side in search for eventual misconceptions of the protocol. In the end, SFI crews re-assessed 40 plots (or at least 5 % of all plots) and evaluated the quality of field work.

Volume estimation

For **volume of tree calculation** (m^3) locally used tariffs are used as for:

- a single tree **tariff's code** (01-60) is selected from SFS forest's compartment data base respectively 8 different **tree species groups** (T_1-T_8). Tariff's **type** (equation) and class (coefficient) are defined by the tariff's code selection.
- the volume of tree is calculated using appropriate tariff's equation (type, class) with tree **diameter** ($D_{1.3}$) as explanatory variable.
- Tariff functions give values for volume of stem over bark (including stem parts (branches) with a diameter of more than 7 cm and a stump).

Equations:

Diameter ($D_{1.3}$) = Circumference ($O_{1.3}$) / π

Three different tariff's **types** (4 equations) and **20 tariff classes** with different coefficients (v_{45}) are used as for:

- even-aged stand/forest, slow Schaeffer's E tariffs

$$v = \frac{v_{45}}{1800} * d_{1,3} * (d_{1,3} - 5) = \frac{v_{45}}{1800} * (d_{1,3}^{2} - 5 * d_{1,3})$$

- selective stand/forest (germ.: *plenterwald*), rapid Algan's P tariffs

$$v = \frac{v_{45}}{1400} * (d_{1,3} - 5) * (d_{1,3} - 10) = \frac{v_{45}}{1400} * (d_{1,3}^{2} - 15 * d_{1,3} + 50)$$

and for trees which diameter ($D_{1.3}$) is thinner than 25 cm:

$$v = \frac{v_{45}}{1400} * (-226{,}33 + 38{,}575 * d_{1,3} - 1{,}9237 * d_{1,3}^{2} + 0{,}04876 * d_{1,3}^{3})$$

- uneven-aged stand/forest, intermediate Čokl's V tariffs

$$v = \frac{v_{45}}{1600} * (d_{1,3} - 2{,}5) * (d_{1,3} - 7{,}5) = \frac{v_{45}}{1600} * (d_{1,3}^{2} - 10 * d_{1,3} + 18{,}75)$$

Table 2: Tariff's coefficients

	TARRIF'S CLASS from 1 to 10 (5)									
10 CLASSES	1		2		3		4		5	
20 CLASSES	1	2	3	4	5	6	7	8	9	10
$k = v_{45}$	1,143	1,200	1,263	1,326	1,396	1,466	1,543	1,620	1,706	1,791

	TARRIF'S CLASS from 6 to 20 (10)									
10 CLASSES	6		7		8		9		10	
20 CLASSES	11	12	13	14	15	16	17	18	19	20
$k = v_{45}$	1,885	1,979	2,084	2,188	2,303	2,418	2,546	2,673	2,814	2,954

Calculation of **volume of small trees** (m^3):

- Volume for single small tree is calculated by Huber's equation (see equation below),
- Volume of single small tree is then multiplied by the number of trees (N) which have the same $D_{1.3}$ and H.

Equations:

Basal area (G) = π * ($D_{1.3}$ / 2)^2

V = G * H = π * ($D_{1.3}$ / 2)^2 * H (Huber's equation – volume of cylinder)

Calculation of **volume of dead wood** (m^3):

- the choose of appropriate method (tariff's or Huber's equation) for volume of dead wood calculation is dependent on **type of dead wood** as for:
    - **tree** (standing dead tree, lying dead tree) calculation is the same as for living tree (using tariff's equations, see upper).
    - **stump**: from diameter (D) and high (H), by Huber equation (V = G * H).
    - **snag**: from diameter (D) and high (H), by Huber equation (V = G * H).
    - **coarse woody debris**: from diameter (D) and length (L), by Huber equation (V = G * L).

Equations: see above!

Growing stock estimation

Calculation of **volume of wood growing stock** per sample plot (m^3/ha):

- to calculate volume of tree per ha (from m^3 to m^3/ha) volume of tree is multiplied by area factor (FP),
- area factors (FP) are calculated on the basis of sample plots areas (P) and are for trees that have diameter ($D_{1.3}$) respectively:
    - from 10 to 29.9 cm: P_2 is 200 m^2, FP_2 is 50,
    - equal or bigger than 30 cm: P_3 is 600 m^2, FP_3 is 16.7,
    - for dead standing tree (code is 2) diameter must be equal or bigger than 30 cm: P_4 is 2000 m^2, FP_4 is 5.

Calculation of **volume of growing stock of small trees** per plot (m^3/ha):

- to calculate volume of small trees per ha (from m^3 to m^3/ha) volume of small trees is multiplied by area factor (FP): P_1 is 30 m^2, FP_1 is 333;

Calculation of **volume of dead wood stock** per plot (m^3/ha):

- to calculate volume of dead wood per ha (from m^3 to m^3/ha), volume of every single piece of dead wood is multiplied by different area factors (FP) according different types of dead wood,
- area factors (FP) are calculated on the basis of the sample plots areas (P) and dead wood types as for:
- **tree** (standing dead tree, lying dead tree), if diameter ($D_{1.3}$) is:
    - from 10 to 29.9 cm: P_2 is 200 m^2, FP_2 is 50,
    - equal or bigger than 30 cm: P_4 is 2000 m^2, FP_4 is 5,
- **stump**: P_2 is 200 m^2, FP_2 is 50,
- **snag.** if diameter (D) is:
    - from 10 to 29.9 cm: P_2 is 200 m^2, FP_2 is 50,
    - equal or bigger than 30 cm: P_4 is 2000 m^2, FP_4 is 5,
- **coarse woody debris.** if diameter (D) is:
    - from 10 to 29.9 cm: P_2 is 200 m^2, FP_2 is 50,
    - equal or bigger than 30 cm: P_4 is 2000 m^2, FP_4 is 5.

Biomass and carbon stock estimation

How to calculate amount of biomass and carbon from volume of growing stock?

Above-ground biomass (AGB):

- growing stock (GS) (m^3/ha) * forest area (ha) → (m^3)
- from GS to carbon stock in AGB (tree species)
    - biomass expansion factors (BEF): GS (m^3) → AGB (m^3)
    - wood density (WD): AGB (m^3) → AGB (t)
    - biomass/carbon factor (CC): AGB (t) → CDWB (t)

Below ground biomass (BGB):

- input data: AGB (t)
- from AGB to carbon stock in BGB (tree species):
    - root-shoot ratio (R): AGB (t) → BGB (t)
    - biomass/carbon factor (CC): BGB (t) → CBGB (t)

Dead wood biomass (DWB):

- dead wood stock (DWS) (m^3/ha) * area (ha) → (m^3)
- from DWS to carbon stock in DWS (tree species):
  - wood density (WD): DWB (m^3) → DWB (t)
  - biomass/carbon factor (CC): DWB (t) → CDWB (t)

As some research studies for national BEF factors for the main tree species are planned to be done in time period 2008-2012, basic wood density (WD) was gained for the main tree species from literature and some research studies as well as from table 3A.1.9 (GPG 2003). BEF **factors are from GPG 2003:**

Table 3: Factors used in calculation (according to GPG 2003)

	D	BEF_1	R	BEF_2	CF
Coniferous	0.407	1.15	0.32	1.35	0.5
Deciduous	0.567	1.20	0.26	1.36	0.5

Increment estimation

The national forest inventory which will be repeated in 2012 will make reliable calculation of growing stock increment possible. Increment can already be derived now from the years 2000 and 2007 inventory data.

Drain statistics estimation

The national forest inventory which will be repeated in 2012 will offer basis for reliable felling assessment, because every tree has appurtenant location data. Plots are not visually marked in any way so they reflex actual management practice.

2 National Forest Inventory 2012 (FECS 2012)

2.1 Background

When designing national forest inventory, i.e. Forest and Forest Ecosystem Condition Survey – FECS 2012 for KP/UNFCCC reporting purposes, recommendations of GPG 2003 and COST Action E43 have been considered as far as possible. FECS 2012 is the third repetition of the national forest inventory, which was for the first time established in 2000 according to international standards. The consistent design and methodology ensure the reliable data sets about volume of wood growing stock; state, changes (increment, felling) – development/trends – of all Slovenian forests.

Convention on long range transboundary air-pollution (UN/ECE 1979) presents the legislative framework for ICP monitoring scheme - Assessment and Monitoring of Air Pollution Effects on Forests (inventory in the year 2000). FECS as it is defined in Official Journal of the Republic of Slovenia (Official Journal of the RS, nr. 92/00, 56/06), presents basis for development of Slovenian national forest inventory design.

2.2 Consistency of sampling grids and their estimates (grid 16x16km, grid 4x4 km; CPP SFS)

During the preparation of FECS 2012 a list of locations was prepared in order to establish inventory plots in 2012. There were some locations of which land use has changed since 2007 from non-forest to forest land due to spontaneous afforestation and some of them from forest to non-forest land due to deforestation. There were 1270 locations (intersections) of systematic grid of 4 x 4 km in Slovenia (Figure 1). The FECS 2012 plot was established if its centre fell into forest. In doing so, the land use map (ALUM 2012) was used for checking. All locations that were surrounded by other land use than forest within the radius of 20 m were checked on the newest orthophotos and included or excluded to FECS survey depending on photointerpretation decision. There were 164 such locations. In total, 760 locations were selected in the FECS 2012 (Table 1)

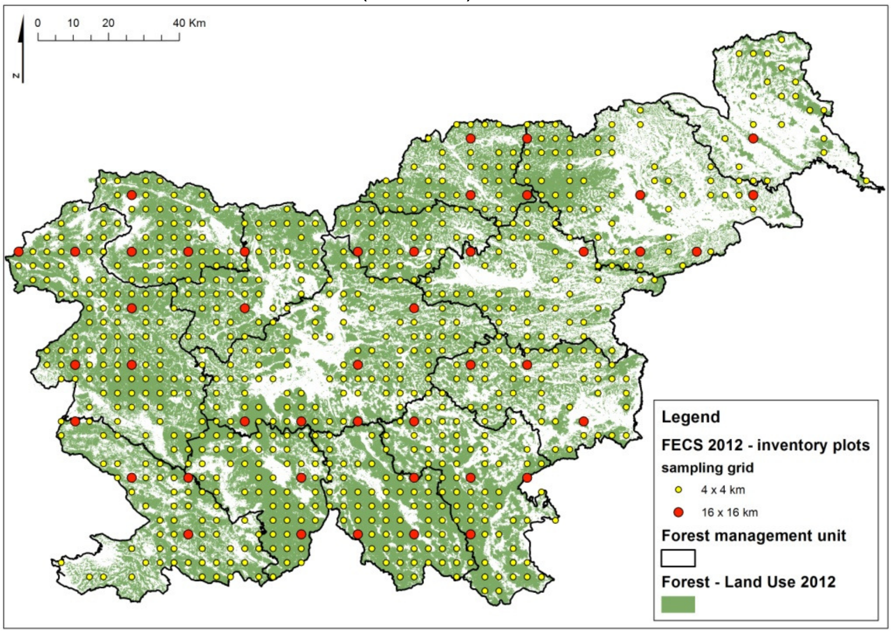

Figure 1: Plot locations of FECS 2012 on systematic grid of 4x4 km and 16x16 km.

Table 1: Number of plot by land use.

Year	Grid	Non-forest	Forest	Total
2012	4 x 4 km	510 (41 %)	760 (59 %)	1270 (100 %)
	16 x 16 km	31 (41 %)	44 (59 %)	75 (100 %)

Table 2: Number of plot by accessibility.

Year	Grid	Non-forest	Forest	Total
2012	4 x 4 km	14 (2 %)	746 (98 %)	760 (100 %)
	16 x 16 km	1 (2 %)	43 (98 %)	44 (100 %)

Table 3: Number of plot by threshold tree.

Year	Grid	Non-forest	Forest	Total
2012	4 x 4 km	736 (99 %)	10 (1 %)	746 (100 %)
	16 x 16 km	44 (100 %)	0 (0 %)	44 (100 %)

2.3 Consistency of CPP (Protocols for slope and edge)

Concentric permanent plot (CPP) consists of four sub-plots of different radius. Various variables are surveyed on these sub-plots (Table 2). The division of CPP into sub-plots is due to optimization of field word. The more frequent variables are measured on smaller, while less frequent on larger sub-plot area.

The threshold values in tree and dead wood biomass measurement are diameters/perimeters of trunk or part of deadwood biomass and height/length of parts of dead wood biomass (Table 4). The threshold values are defined for each of CPP sub-plot, which are called as CPP1, CPP2, CPP3 and CPP4 and with different radius (Table 4).

Table 4: Basic data on CPP with some of threshold values

Plot attribute	**KPP1**	**KPP2**	**KPP3**	**KPP4**
Plot radius [m]	3,09	7,98	13,82	25,23
Plot area [ar]	0,3	2,0	6,0	20,0
SITE AND STAND CHARACTERISTICS SURVEY				
Site characteristics	Expositions, stoniness, slope etc.			
Stand characteristics	Type of forest, canopy closure etc.			
LIVING TREE SURVEY				
Standing live trees	0 cm < $D_{1,3}$ < 10 cm H ≥ 1,3 m, by height class	$D_{1,3}$ ≥ 10 cm oz. $Perimeter_{1,3}$ ≥ 31 cm	$D_{1,3}$ ≥ 30 cm oz. $Perimeter_{1,3}$ ≥ 94 cm	/
DEADWOOD SURVEY				
Standing dead trees	$D_{1,3}$ ≥ 10 cm		$D_{1,3}$ ≥ 30 cm	
Lying dead trees	$D_{1,3}$ ≥ 10 cm		$D_{1,3}$ ≥ 30 cm	
Stumps	D ≥10 cm H ≥ 20 cm		/	
Snags	D ≥ 10 cm H ≥ 50 cm		D ≥ 30 cm H ≥ 50 cm	
Coarse woody debris (CWD)	D ≥ 10 cm L ≥ 50 cm		D ≥ 30 cm L ≥ 50 cm	

Notes: $D_{1,3}$ – tree diameter at breast height (height 1.3 m from the ground); D – CWD diameter; H – height; L – length

The condition for consistent comparability of data among the plots is fulfilled taking into account:

a. horizontal plot projection and
b. plot area in the forest.

Ad a) Plot radius has to be corrected according to plot slope in order to ensure equal plot area in each survey (Figure 4). Thus, the horizontal projection stays the same all the time. The plot slope or inclination is the angle between a virtual horizontal projection and slope direction (Figure 4). Plot radius is the distance between the centre and edge of the plot (Figure 5)

By increasing the plot slope, thus extending the plot radius. Table 5 shows the corrected radius of sub-plots for few cases of different slope of the terrain. So, larger the slope of terrain the longer vertical radius of the inventory plot.

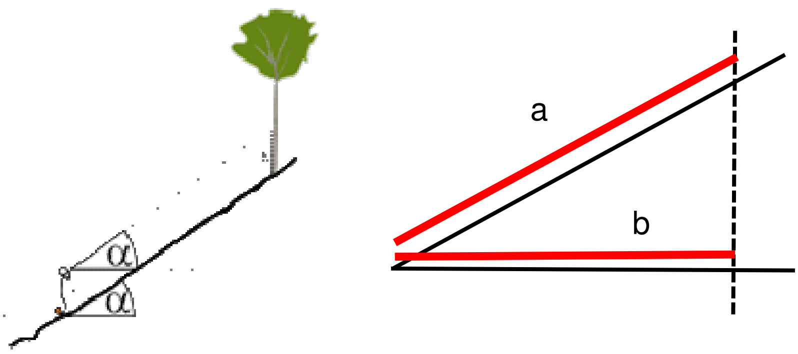

Figure 4: Scheme of measuring the slope of the terrain and vertical (a) and horizontal (b) distance to the tree.

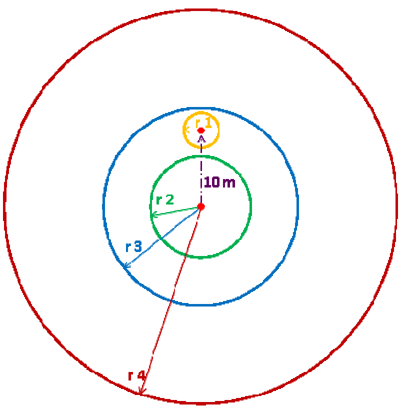

Figure 5: Plot division by different sub-plot radius.

Table 5: Examples of correction for sub-plot radius.

CPP		CPP 1	CPP 2	CPP 3	CPP 4
HORIZONTAL AREA	**(ar)**	**0,3**	**2,0**	**6,0**	**20,0**
HORIZONTAL RADIUS (r)	**(m)**	**3,09**	**7,98**	**13,82**	**25,23**
VERTICAL RADIUS					
SLOPE		CPP 1	CPP 2	CPP 3	CPP 4
Degrees	%	m	m	m	m
0	0	3,09	7,98	13,82	25,23
2	3	3,09	7,98	13,82	25,24
20	36	3,19	8,23	14,26	26,03
40	84	3,53	9,12	15,79	28,83
57	154	4,19	10,81	18,73	34,19

Ad b) Each sub-plot has a different area weight due to differences in surface areas (radius). When calculating the hectare values the area of each following sub-plot within the forest should be taken into account: CPP2 (2 ars), CPP3 (6 ars), CPP4 (20 ars). In the year 2012, a share of the plot, which was in forest, was estimated based on variable »edge« and »edgedistance«.

EDGE – estimate of the share of the plot (%), which is in the forest.
EDGEDISTANCE – distance from CPP centre to non-forest land use.

For all plots, which were out of the forest according to surveyors estimation, the share that is within the forest was estimated based on interpretation of digital orthophoto (Figure 6).

Figure 6: Example of the plot, which lies partly out of the forest.

2.4 Methods of quality assurance and quality control of CCP data

2.4.1 Tablet for field data entry

In 2012 three field teams of the GIS, which inventoried the plots on the grid of 16 x 16 km, tested a direct data entry in the field using the tablet computers Samsung Galaxy Tab 2. The major goal of the latter was to reduce the costs, which are coming afterwards when digitizing the data from the field papers. Additionally, one of the goals was also to reduce the potential errors, which can occur during the entering data into database. It was found that the use of the current market available applications allows for entering data in the field, however it is time consuming since these application are not well adapted to field work. Therefore, there is a need to develop application, which would ensure a better overview of the data, user friendly data entering, and already built-in logical controls, which would remind the field worker in case of illogical measurement entry.

Some of the currently available tablet computers have a serial GPS, which can make orientation and locating the plot for field teams easier.

2.4.2 Logical control of data at the plot level (land use and destination determination of CPP, site, slope etc.) and trees (diameter, tree species, height)

All data were checked after finishing the entry of all measured or estimated data from field data sheets into digital database.

Database was divided to:

1. plot data,
2. data on living trees reaching the threshold of the measure ($D_{1,3} \geq 10$ cm),
3. data on deadwood biomass and
4. data on living trees below the threshold of the measure (0 cm < $D_{1,3}$ < 10 cm) .

In the same way also the logical controls were prepared that were basis for identification of potential errors, which can occur during the measurement or when entering the data. Each of error, which was previously notified in the field data sheets, was checked and corrected. Therefore, all data are equipped by notes in the digital copies, which enable us to trace corrections.

Logical controls are divided to two levels, as follows:

1. Control for checking whether the correct codes were used in line with the guidelines.
2. Cross-checking of the measured data or codes.

Examples, for the first level; control if the correct coding was used for tree species in database compared to that one in the guidelines, and for the second level; control if the tree, which was measured for the first time in 2012 a diameter ≥ 10 cm, has the correct code 4 (ingrowth).

Following controls of data were carried out at the first level:

1. Plot data: review of missing data, checking for correct use of codes, checking for consistency between plot slope and correction of plot radius, checking of plots, which were partly out of forest (forest edge), review on correct use of coding for plot status etc.
2. Tree data ($D_{1,3} \geq 10$ cm): review of missing data, checking for correct use of codes (tree species, tree structure, radius, azimuth, code, dbh etc.), review on correct use of units.
3. Deadwood data: review of missing data, review of plots without recordings, checking for correct use of codes (tree species, deadwood type etc.)
4. Living tree data (0 cm < $D_{1,3}$ < 10 cm): review of missing data, review of plots without recordings, checking for correct use of codes (tree species, height, diameter etc.)

2.4.3 Protocols for calculation of parameters and consistency with the international standards

2.4.3.1 Stand density and species composition (number of trees, basal area, growing stock)

For each parameter the presentation is given including the definition, parameter type and protocol for calculation, which was performed in R program (R Development Core Team, 2013). All calculations were then copied to program C# on basis of which the program works for the calculation of inventory data.

2.4.3.1.1 Number of trees/ha

- **Definition:** number of trees per hectare, of which dbh ≥ 10 cm.
- **Type:** direct; calculated on basis of basic data on trees measured on the plot.
- **Protocol:** number of all trees on plot reaching the threshold of the measure. All trees are considered that had in 2012 the following codes: 0 (no change), 3 (in-growth), 4 (forgotten), 9 (corrected previous diameter), 13 (new plot), 15 (over-growth). In the first step absolute number of trees per plot is calculated, followed by recalculation per hectare and in the last step also data on the share of plot lying in the forest (forest edge) is included in calculation.

2.4.3.1.2 Basal area/ha

- **Definition:** Basal area [m2/ha] is defined as cumulative hectare area of intersections of trees reaching the threshold of the measure at the breast height ($D_{1,3}$ ≥ 10 cm)
- **Type:** derived; calculated on basis of tree diameters surveyed on the plot.
- **Protocol:** based on the individual tree diameter the area of intersection of the tree trunk at the breast height presuming a shape of the circle. Basal area of each tree is then multiplied by area factor depending on the size of diameter. Basal area on the plots is the sum of basal area of standing trees.

2.4.3.1.3 Growing stock/ha

- **Definition:** Growing stock [m^3/ha] is the volume of living trees with a dbh ≥ 10 cm. The volume includes trunk over bark from ground to the crown top, where its diameter reaches a threshold value of 7 cm. This includes also the volume of the stump and branches, but also taking into account the threshold diameter of 7 cm.
- **Type:** derived; calculated on basis of diameter and height of trees on the plot.
- **Protocol:** Calculation of tree volume was done using the adapted French tariffs. The type and class of the tariffs were taken from SFS databases, which are determined for 8 groups of tree species at the level of forest management section (spruce, fir, other conifers, beech, oaks, valuable deciduous, hardwood deciduous, and softwood deciduous). For each tree according to tree species in the database an appropriate code of SFS tariffs (TR1 to TR8), which determines tariff type and class. The tree volume is calculated using the equation (type) and coefficient (class) of the tariffs and tree diameter at the breast height ($D_{1,3}$).

2.4.3.2 Increment DH

2.4.3.2.1 Models of diameter increment (by 6 main tree species)

2.4.3.2.1.1 Introduction

Definition of increment

Current increment represents an increase in chest diameter of trees or the volume of trees in a given period of time.

2.4.3.2.1.2 Methods

In this study, we used MGGE data from year 2007 and 2012. In both inventories the volume of 10,026 trees was measured, and then the annual increment was calculated. Hereinafter the data of 6 groups of the main tree species (Table 6) was used.

In the survey there were 14 independent variables, which can be divided into:

a. site characteristics (altitude, aspect, slope, bed rock, the characteristics of the terrain, rockiness) and
b. characteristics of tree growing site (chest diameter, stand basal area, stand cower, development phase, stand growing stock, type of forest, number of trees, tree social status)

Social status and cover variables were united in the so-called "dummy" variables. The social status 1 has trees in the roof of the stand canopy (dominant, dominant and subdominant). The social status 2 represent trees that occupy the growing space beneath the roof of the stand canopy (pushed and undergrowth trees). Stand cover 1 includes plots that had a tight, normal or slight cover and class 2 represent plots with gap or ripped cover.

Altitude, slope, chest diameter, stand basal area, growing stock and the number of tree species are continuous variables. In the results there are some variables (altitude, slope, dbh and basal area) displayed in groups (boxplot) because more clear data presentation. Other variables are categorical.

The growth of the main tree species groups were analyzed with a variety of statistical methods, namely (i) determine which of the independent variable are affecting the tree increment and (ii) what is the dependence of the tree regarding the increment of the selected independent variables.

Ad (i) The relationship of the dependent variable with continuous independent variables was assessed with Kendall - tau correlation coefficient. To determine the relationship with categorical variables the non-parametric tests (Kruskal-Wallis) and the posterior pairwise comparisons was used because of the non-homogeneity of variances.

Ad (ii) For the determination of the dependency of trees increment to explanatory variables, the method of regression models was used. Since data on increment does not correspond to the condition of normal distribution (Figure 8), the data were previously transformed for the purposes of the analysis.

2.4.3.2.1.3 *Results:*Increment of trees between 2007 and 2012

Table 6: Descriptive statistics for mean annual increment for selected groups of tree species

				Annual increment	
Group of tree species	N. of trees	Mean	SD	Median	CV (%)
Spruce	2507	0.38	0.29	0.32	76
Fir	578	0.45	0.33	0.38	73
Beech	3199	0.33	0.29	0.25	88
Oak	612	0.37	0.27	0.32	73
Valuable deciduous	673	0.35	0.28	0.25	80
Other hardwood d.	1512	0.27	0.28	0.19	104

2.4.3.3 Deadwood

2.4.3.3.1 Number/ha

- **Definition:** number of pieces of dead wood per hectare.
- **Type:** direct; calculated from basic data on dead wood on the plots.
- **Protocol:** the number of all pieces of dead woody biomass on the plot. In the first steep the absolute number of pieces on the plot is calculated, then the values per hectare are calculated and finally the data on what proportion of the plot is located within the forest (forest edge) is also taking into account.

2.4.3.3.2 Volume/ha

- **Definition:** Volume [m^3/ha] includes all deadwood biomass (dead standing, dead lying, stumps, coarse woody debris, snags), which reaches a minimal dimensions (table 2).
- **Type:** derived; calculated from deadwood data (mean diameter and height or length) surveyed on the plot.
- **Protocol:** For dead standing and lying trees the adapted French tariffs were used. Volume of CWD, stump and snag is calculated according to Huber's equation (length x mean diameter). Volume of deadwood on plot (m^3/ha) is calculated as volume of each deadwood type multiplied by the area factor.

3 Information relating to Cropland Management, Grazing Land Management, Revegetation and Wetland Drainage and Rewetting

This annex was prepared based on the requirements pursuant to Article 40.4(b) of the Regulation (EU) 749/2014. In compliance with this article, explanatory information are provided for cropland management and grazing land management on methodologies and data used as required in the national inventory report in accordance with Decision 2/CMP.8 under the Kyoto Protocol and its Annex II.

General information

Under Article 3, paragraph 4 of the Kyoto Protocol (KP), Slovenia does not report emissions and removals from Cropland Management (CM), Grazing Land Management (GM), Revegetation and Wetland Drainage and Rewetting since these activities have not been elected in the first nor in the second commitment period. However, Slovenia did provide estimation of emission and removals from CM and GM in compliance with the Article 3.2(b) of the Decision 529/2013/EU, which states that Member States shall, prior to 1 January 2022, provide and submit to the Commission by 15 March each year initial, preliminary and non-binding annual estimates of emissions and removals from cropland management and grazing land management using, where appropriate, IPCC methodologies.

The estimation of emissions and removals from CM and GM has been prepared according to land-based approach as suggested by guidance (Weiss et al. 2015) and in line with 2006 IPCC Guidelines and 2013 IPCC KP Supplement. Emissions from cropland management and grazing land management in 2014 are estimated to be 105.96 kt CO_2 and 12.49 kt CO_2, respectively. Although estimates resulting from CM were provided, the "remaining" category of cropland has not yet been stratified according to management practices, crop rotation, tillage reduction, crop residue return or fertiliser input. Therefore, it is assumed that the emissions from CM are underestimated. The stratification will be provided through a targeted research project, which will allow us to estimate annual carbon stock changes in mineral soil from CM using a default IPCC methodology.

Is the activity a key category? The following key categories relevant to the CM in GM are:
- Land converted to Cropland (T),
- Cropland remaining Cropland (T),
- Land converted to Grassland (L, T).

Land-related information

Annual and total areas under Article 3.4 for cropland management and grazing land management were adopted from the Statistical Yearbook of the Statistical Office RS and targeted research project "Bases for improving the methodology of greenhouse gas emissions in relation to land use, land use change and forestry" (detailed description in the NIR 20016, sub-chapter 6.2.1.1). For the purpose of reporting the GHG emissions under the Decision 529/2013/EU the CM according to guidance (Weiss et al. 2015) include:
- all areas of cropland remaining cropland,
- areas with any land-use change to Cropland, except from Forest land,
- areas converted from Cropland to any land-use category, except Grassland included in GM.

Identification of the GM land was used by the same approach.

Until the submission of final annual estimates for accounting of CM and GM, definitions may change, however, it is expected that consistency in current definitions with the UNFCCC inventory will remain the same.

The following sources of data related to reporting for LULUCF were used or show potential for identification of CM and GM lands;

- Aerophotographs, 1:17.500 (1975-2006, The Surveying and Mapping Authority RS)
- Orthophotos, 1:5.000 (2001- , Surveying and Mapping Authority of the RS)
- Agricultural Land Use Map, 1:5.000 (2002- , Ministry of Agriculture, Forestry and Food of the RS)
- LPIS/IACS data, 1:5.000 (2002- , Ministry of Agriculture, Forestry and Food of the RS)
- Satellite images Landsat (1984-2014, ZRC SAZU)

Activity-specific information

Methodological principles used for estimations of carbon stock changes and greenhouse gas emissions/removals under Kyoto Protocol were the same as for estimations under UNFCCC reporting. Calculations were made in accordance with IPCC 2006 Guidelines and with the IPCC 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.

Further information can be found in the NIR (chapters 6.4 and 6.5.) and under methodology description below.

Direct human-induced

By applying the present approach it is assumed that all area of cropland and grassland is subject to anthropogenic activities, meaning those categories are consistent with cropland management and grazing land management, respectively. Once definitions are developed and the system is put in place, certain areas could be excluded from the activities (e.g. natural grasslands in mountain regions).

Information on the base year

No further information is available.

Methodology for the relevant estimations

The methodologies used for estimation of emissions and removals from CM and GM are mostly related to Tier 1 level. As CM is assumed to be a key category, it is expected that effort will be made to improve the reporting regarding the completeness, pools accounted for, and methods for applying higher Tier level once the system is put in place.

<u>Cropland Management</u>

Annual changes in carbon stocks of above- and below-ground biomass

Above-ground woody biomass:

- Accounted for? Yes
- Tier implemented: 1

- Description: default method of the 2006 IPCC Guidelines was used

Below-ground biomass accumulation:
- Accounted for? No
- Tier implemented: 1
- Description: data to estimate CSC in below-ground biomass are not available

Annual changes in DOM (Dead Wood/Litter):
- Accounted for? No
- Tier implemented: 1
- Description: under Tier 1, it is assumed that the net carbon stock change in DOM is zero

Carbon Stock Change in Soils:

i. Mineral Soils:
- Accounted for? Yes
- Tier implemented: 1
- Description: estimation in accordance with default method

ii. Organic Soils:
- Accounted for? Yes
- Tier implemented: 1
- Description: estimation in accordance with default method

Emissions from biomass burning:
- Accounted for? No
- Tier implemented: 1
- Description: emission from biomass burning are assumed not occurring on cropland, since this is not a common practice in Slovenia

<u>Grazing Land Management</u>

Annual changes in carbon stocks of above- and below-ground biomass

Above-ground woody biomass:
- Accounted for? Yes
- Tier implemented: 1
- Description: default method of the 2006 IPCC Guidelines was used

Below-ground biomass accumulation:
- Accounted for? No
- Tier implemented: 1
- Description: data to estimate CSC in below-ground biomass are not available

Annual changes in DOM (Dead Wood/Litter):
- Accounted for? No
- Tier implemented: 1
- Description: under Tier 1, it is assumed that the net carbon stock change in DOM is zero

Carbon Stock Change in Soils:

i. Mineral Soils:

- Accounted for? Yes
- Tier implemented: 1
- Description: estimation in accordance with default method

ii. Organic Soils:

- Accounted for? No
- Tier implemented: 1
- Description: drainage of organic soil on grasslands is not a common practice in Slovenia

Emissions from biomass burning:

- Accounted for? No
- Tier implemented: 1
- Description: emission from biomass burning are not estimated since no activity data are available

Uncertainty estimates: availability, methods, and results

No further information is available.