ANNEX 3

3.a Additional data for agriculture

3.b Other detailed methodological descriptions for LULUCF

3.a Additional data for agriculture

Cattle population 2000-2012

Population	2000	2001	2002	2003	2004	2005	2006
Dairy cattle	**140236**	**135805**	**139980**	**130711**	**134009**	**120273**	**112510**
Non-dairy cattle	**353434**	**341270**	**333262**	**319515**	**317127**	**332244**	**341523**
Other cows	53896	52777	55011	55165	48065	56955	60511
Young cattle under 1 year	145730	136992	138783	131142	136689	135504	136617
Fattening bulls & steers older than 1 year	69873	69324	61929	56932	59803	66662	68404
Heifers for fattening older than one year	13747	11865	8740	7650	7734	8915	8236
Breeding heifers 1-2 years	52841	54192	52791	52189	49030	48945	50006
Breeding heifers - over 2 years	16427	15001	15124	15526	15057	14208	16777
Breeding bulls-over 2 years	920	1120	884	910	749	1053	972
Cattle - TOTAL	**493670**	**477075**	**473242**	**450226**	**451136**	**452517**	**454033**

Population	2007	2008	2009	2010	2011	2012
Dairy cattle	**116391**	**113400**	**113103**	**109467**	**109068**	**111022**
Non-dairy cattle	**363190**	**356583**	**359775**	**360684**	**353232**	**349041**
Other cows	61245	62562	60973	63887	61671	56503
Young cattle under 1 year	149750	145375	147338	146770	146203	146560
Fattening bulls & steers older than 1 year	73967	69816	69664	68463	64737	64575
Heifers for fattening older than one year	8470	9911	9691	10655	9936	15076
Breeding heifers 1-2 years	48719	48551	50319	48778	48202	46364
Breeding heifers - over 2 years	19977	18965	19915	20231	20147	17020
Breeding bulls-over 2 years	1062	1403	1875	1900	2336	2943
Cattle - TOTAL	**479581**	**469983**	**472878**	**470151**	**462300**	**460063**

Other parameters, Cattle – 1986-2012

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Dairy cattle									
DE (%)	62.2	62.1	62.1	62.1	62.1	63.0	62.2	62.1	62.6
Energy requirements (MJ / animal / year)									
NE maintenance	13060	13028	13033	13047	13035	13322	13071	13050	13179
NE grazing	131	131	131	131	131	147	157	169	184
NE lactation	8346	8190	8218	8287	8231	9697	8499	8442	9140
NE pregnancy	926	920	921	920	922	947	925	928	932
NE total	22464	22269	22302	22384	22318	24112	22653	22588	23435
NE/DE	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
GE	71346	70899	70978	71167	71020	75122	71887	71799	73776
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	1345	1341	1342	1344	1342	1385	1354	1355	1377

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Dairy cattle									
DE (%)	62.9	64.1	64.4	64.6	64.9	65.5	65.8	66.5	66.2
Energy requirements (MJ / animal / year)									
NE maintenance	13273	13668	13754	13822	13918	14138	14245	14474	14394
NE grazing	199	218	233	248	263	281	283	288	286
NE lactation	9668	11731	12219	12624	13172	14385	14989	16229	15824
NE pregnancy	939	970	971	972	981	999	1007	1023	1011
NE total	24078	26587	27177	27666	28333	29802	30524	32014	31515
NE/DE	0.51	0.51	0.51	0.51	0.52	0.52	0.52	0.52	0.52
GE	75281	80850	82171	83271	84748	88234	89781	92903	91877
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	1393	1446	1459	1470	1484	1517	1530	1554	1547

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Dairy cattle									
DE (%)	65.9	66.9	67.2	67.3	67.3	67.0	66.9	66.9	67.1
Energy requirements (MJ / animal / year)									
NE maintenance	14272	14638	14770	14781	14803	14667	14659	14659	14703
NE grazing	284	291	294	294	294	292	292	292	292
NE lactation	15211	17151	17708	17831	17881	17244	17246	17264	17551
NE pregnancy	996	1019	1025	1023	1024	1009	1006	1004	1007
NE total	30763	33099	33797	33929	34003	33213	33204	33218	33554
NE/DE	0.52	0.52	0.52	0.52	0.52	0.52	0,52	0,52	0,52
GE	90335	95172	96481	96805	96903	95344	95359	95406	96134
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	1536	1571	1576	1580	1585	1570	1572	1573	1579

	1986	1987	1988	1989	1990	1991	1992	1993	1994
Other cows									
DE (%)	*	*	*	*	*	62.5	62.5	62.5	62.5
Energy requirements (MJ / animal / year)	*	*	*	*	*				
NE maintenance	*	*	*	*	*	13171	13171	13171	13171
NE grazing	*	*	*	*	*	262	262	262	262
NE lactation	*	*	*	*	*	9330	9330	9330	9330
NE pregnancy	*	*	*	*	*	940	940	940	940
NE total	*	*	*	*	*	23702	23702	23702	23702
NE/DE	*	*	*	*	*	0.51	0.51	0.51	0.51
GE	*	*	*	*	*	74663	74663	74663	74663
Ym	*	*	*	*	*	0.06	0.06	0.06	0.06
VS (kg/year)	*	*	*	*	*	1394	1394	1394	1394

* there were no suckler cows before 1991

	1995	1996	1997	1998	1999	2000	2001	2002	2003
Other cows									
DE (%)	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5
Energy requirements (MJ / animal / year)									
NE maintenance	13171	13171	13171	13171	13171	13171	13171	13171	13171
NE grazing	262	262	262	262	262	262	262	262	262
NE lactation	9330	9330	9330	9330	9330	9330	9330	9330	9330
NE pregnancy	940	940	940	940	940	940	940	940	940
NE total	23702	23702	23702	23702	23702	23702	23702	23702	23702
NE/DE	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
GE	74663	74663	74663	74663	74663	74663	74663	74663	74663
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	1394	1394	1394	1394	1394	1394	1394	1394	1394

	2004	2005	2006	2007	2008	2009	2010	2011	2012
Other cows									
DE (%)	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5
Energy requirements (MJ / animal / year)									
NE maintenance	13171	13171	13171	13171	13171	13171	13171	13171	13171
NE grazing	262	262	262	262	262	262	262	262	262
NE lactation	9330	9330	9330	9330	9330	9330	9330	9330	9330
NE pregnancy	940	940	940	940	940	940	940	940	940
NE total	23702	23702	23702	23702	23702	23702	23702	23702	23702
NE/DE	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51
GE	74663	74663	74663	74663	74663	74663	74663	74663	74663
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	1394	1394	1394	1394	1394	1394	1394	1394	1394

	1986	2000	2001	2002	2003	2004	2005	2006
Other non-dairy cattle								
DE (%)	67	67	67	67	67	68	68	68
Energy requirements (MJ / animal / year)								
NE maintenance	7340	8198	8284	8140	8212	8101	8201	8271
NE grazing	97	183	185	182	184	181	183	185
NE growth	3032	3590	3631	3592	3624	3631	3696	3726
NE pregnancy	116	55	52	54	58	56	51	59
NE total	10586	12026	12151	11968	12077	11969	12132	12242
NE/DE	0.519	0.521	0.522	0.522	0.522	0.522	0.522	0.522
NEg/DE	0.317	0.321	0.321	0.321	0.321	0.322	0.322	0.322
GE	36451	40983	41383	40763	41118	40693	41182	41546
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	613	739	744	737	741	734	738	743

	2007	2008	2009	2010	2011	2012
Other non-dairy cattle						
DE (%)	68	68	68	68	68	68
Energy requirements (MJ / animal / year)						
NE maintenance	8250	8239	8233	8234	8215	8195
NE grazing	184	184	184	184	184	183
NE growth	3791	3721	3632	3647	3658	3679
NE pregnancy	66	64	66	68	69	58
NE total	12292	12208	12115	12133	12125	12114
NE/DE	0.523	0.523	0.522	0.522	0.522	0.522
NEg/DE	0.323	0.322	0.321	0.322	0.322	0.322
GE	41602	41406	41205	41241	41174	41074
Ym	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	742	742	742	742	741	737

No data are available for the period 1987-1999. The final emission factors were interpolated on the basis of years 1986 and 2000. More detailed data for other non-dairy cattle are available since 2000 and are presented on the tables bellow.

	2000	2001	2002	2003	2004	2005	2006
Young cattle under 1 year							
DE (%)	68.2	68.3	68.4	68.5	68.6	68.6	68.7
Energy requirements (MJ / animal / year)							
NE maintenance	6078	6104	6134	6165	6190	6203	6229
NE grazing	136	136	137	138	138	139	139
NE growth	3404	3440	3483	3526	3563	3582	3619
NE pregnancy	0	0	0	0	0	0	0
NE total	9618	9681	9755	9829	9892	9924	9988
NE/DE	0.52	0.52	0.52	0.52	0.52	0.53	0.53
NEg/DE	0.32	0.33	0.33	0.33	0.33	0.33	0.33
GE	32741	32915	33117	33319	33492	33579	33752
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	519	520	522	523	525	525	526

	2007	2008	2009	2010	2011	2012
Young cattle under 1 year						
DE (%)	69.0	68.8	68.5	68.6	68.7	68.7
Energy requirements (MJ / animal / year)						
NE maintenance	6306	6242	6165	6182	6225	6225
NE grazing	141	140	138	138	139	139
NE growth	3732	3638	3526	3551	3613	3613
NE pregnancy	0	0	0	0	0	0
NE total	10180	10020	9829	9871	9977	9977
NE/DE	0.53	0.53	0.52	0.52	0.53	0.53
NEg/DE	0.33	0.33	0.33	0.33	0.33	0.33
GE	34270	33838	33319	33435	33723	33723
Ym	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	530	527	523	524	526	526

	2000	2001	2002	2003	2004	2005	2006
Fattening bulls and steers older than 1 year							
DE (%)	68.2	68.3	68.4	68.5	68.6	68.6	68.7
Energy requirements (MJ per animal and year)							
NE maintenance	11227	11227	11227	11227	11227	11227	11227
NE grazing	251	251	251	251	251	251	251
NE growth	5244	5287	5336	5386	5429	5450	5493
NE pregnancy	0	0	0	0	0	0	0
NE total	16722	16765	16815	16864	16907	16928	16971
NE/DE	0.52	0.52	0.52	0.52	0.52	0.53	0.53
NEg/DE	0.32	0.33	0.33	0.33	0.33	0.33	0.33
GE	55770	55852	55947	56042	56123	56164	56245
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	883	882	881	880	879	878	877

	2007	2008	2009	2010	2011	2012
Fattening bulls and steers older than 1 year						
DE (%)	69.0	68.8	68.5	68.6	68.7	68.7
Energy requirements (MJ per animal and year)						
NE maintenance	11227	11227	11227	11227	11227	11227
NE grazing	251	251	251	251	251	251
NE growth	5621	5514	5386	5414	5486	5486
NE pregnancy	0	0	0	0	0	0
NE total	17099	16992	16864	16893	16964	16964
NE/DE	0.53	0.53	0.52	0.52	0.53	0.53
NEg/DE	0.33	0.33	0.33	0.33	0.33	0.33
GE	56485	56285	56042	56096	56231	56231
Ym	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	874	877	880	879	878	878

	2000	2001	2002	2003	2004	2005	2006
Heifers for fattening older than 1 year							
DE (%)	68.2	68.3	68.4	68.5	68.6	68.6	68.7
Energy requirements (MJ / animal / year)							
NE maintenance	11227	11227	11227	11227	11227	11227	11227
NE grazing	251	251	251	251	251	251	251
NE growth	5244	5287	5336	5386	5429	5450	5493
NE pregnancy	0	0	0	0	0	0	0
NE total	16722	16765	16815	16864	16907	16928	16971
NE/DE	0.52	0.52	0.52	0.52	0.52	0.53	0.53
NEg/DE	0.32	0.33	0.33	0.33	0.33	0.33	0.33
GE	55770	55852	55947	56042	56123	56164	56245
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	883	882	881	880	879	878	877

	2007	2008	2009	2010	2011	2012
Heifers for fattening older than 1 year						
DE (%)	69.0	68.8	68.5	68.6	68.7	68.7
Energy requirements (MJ / animal / year)						
NE maintenance	11227	11227	11227	11227	11227	11227
NE grazing	251	251	251	251	251	251
NE growth	5621	5514	5386	5414	5486	5486
NE pregnancy	0	0	0	0	0	0
NE total	17099	16992	16864	16893	16964	16964
NE/DE	0.53	0.53	0.52	0.52	0.53	0.53
NEg/DE	0.33	0.33	0.33	0.33	0.33	0.33
GE	56485	56285	56042	56096	56231	56231
Ym	0.06	0.06	0.06	0.06	0.1	0.06
VS (kg/year)	874	877	880	879	878	878

	2000	2001	2002	2003	2004	2005	2006
Breeding heifers 1-2 years							
DE (%)	64.7	64.7	64.7	64.7	64.7	64.7	64.7
Energy requirements (MJ / animal / year)							
NE maintenance	11480	11480	11480	11480	11480	11480	11480
NE grazing	257	257	257	257	257	257	257
NE growth	3861	3861	3861	3861	3861	3861	3861
NE pregnancy	0	0	0	0	0	0	0
NE total	15598	15598	15598	15598	15598	15598	15598
NE/DE	0.51	0.51	0.51	0.51	0.51	0.51	0.51
NEg/DE	0.31	0.31	0.31	0.31	0.31	0.31	0.31
GE	54470	54470	54470	54470	54470	54470	54470
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	959	959	959	959	959	959	959

	2007	2008	2009	2010	2011	2012
Breeding heifers 1-2 years						
DE (%)	64.7	64.7	64.7	64.7	64.7	64.7
Energy requirements (MJ / animal / year)						
NE maintenance	11480	11480	11480	11480	11480	11480
NE grazing	257	257	257	257	257	257
NE growth	3861	3861	3861	3861	3861	3861
NE pregnancy	0	0	0	0	0	0
NE total	15598	15598	15598	15598	15598	15598
NE/DE	0.51	0.51	0.51	0.51	0.51	0.51
NEg/DE	0.31	0.31	0.31	0.31	0.31	0.31
GE	54470	54470	54470	54470	54470	54470
Ym	0.06	0.06	0.06	0.06	0.1	0.06
VS (kg/year)	959	959	959	959	959	959

	2000	2001	2002	2003	2004	2005	2006
Breeding heifers - over 2 years							
DE (%)	63.1	63.1	63.1	63.1	63.1	63.1	63.1
Energy requirements (MJ / animal / year)							
NE maintenance	14067	14067	14067	14067	14067	14067	14067
NE grazing	315	315	315	315	315	315	315
NE growth	3706	3706	3706	3706	3706	3706	3706
NE pregnancy	994	994	994	994	994	994	994
NE total	19081	19081	19081	19081	19081	19081	19081
NE/DE	0.51	0.51	0.51	0.51	0.51	0.51	0.51
NEg/DE	0.30	0.30	0.30	0.30	0.30	0.30	0.30
GE	67343	67343	67343	67343	67343	67343	67343
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	1240	1240	1240	1240	1240	1240	1240

	2007	2008	2009	2010	2011	2012
Breeding heifers - over 2 years						
DE (%)	63.1	63.1	63.1	63.1	63.1	63.1
Energy requirements (MJ / animal / year)						
NE maintenance	14067	14067	14067	14067	14067	14067
NE grazing	315	315	315	315	315	315
NE growth	3706	3706	3706	3706	3706	3706
NE pregnancy	994	994	994	994	994	994
NE total	19081	19081	19081	19081	19081	19081
NE/DE	0.51	0.51	0.51	0.51	0.51	0.51
NEg/DE	0.30	0.30	0.30	0.30	0.30	0.30
GE	67343	67343	67343	67343	67343	67343
Ym	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	1240	1240	1240	1240	1240	1240

	2000	2001	2002	2003	2004	2005	2006
Breeding bulls-over 2 years							
DE (%)	60.6	60.6	60.6	60.6	60.6	60.6	60.6
Energy requirements (MJ / animal / year)							
NE maintenance	15995	15995	15995	15995	15995	15995	15995
NE grazing	358	358	358	358	358	358	358
NE growth	0	0	0	0	0	0	0
NE pregnancy	0	0	0	0	0	0	0
NE total	16352	16352	16352	16352	16352	16352	16352
NE/DE	0.50	0.50	0.50	0.50	0.50	0.50	0.50
NEg/DE	0.29	0.29	0.29	0.29	0.29	0.29	0.29
GE	53859	53859	53859	53859	53859	53859	53859
Ym	0.06	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	1058	1058	1058	1058	1058	1058	1058

	2007	2008	2009	2010	2011	2012
Breeding bulls-over 2 years						
DE (%)	60.6	60.6	60.6	60.6	60.6	60.6
Energy requirements (MJ / animal / year)						
NE maintenance	15995	15995	15995	15995	15995	15995
NE grazing	358	358	358	358	358	358
NE growth	0	0	0	0	0	0
NE pregnancy	0	0	0	0	0	0
NE total	16352	16352	16352	16352	16352	16352
NE/DE	0.50	0.50	0.50	0.50	0.50	0.50
NEg/DE	0.29	0.29	0.29	0.29	0.29	0.29
GE	53859	53859	53859	53859	53859	53859
Ym	0.06	0.06	0.06	0.06	0.06	0.06
VS (kg/year)	1058	1058	1058	1058	1058	1058

Allocation - cattle

Dairy cattle	Liquid systems	Solid storage	Pasture	Other
1986	34.82	59.28	5.90	0.00
1987	34.82	59.28	5.90	0.00
1988	34.82	59.28	5.90	0.00
1989	34.82	59.28	5.90	0.00
1990	34.82	59.28	5.90	0.00
1991	35.64	57.88	6.48	0.00
1992	36.45	56.49	7.06	0.00
1993	37.27	55.09	7.64	0.00
1994	38.09	53.69	8.22	0.00
1995	38.91	52.29	8.80	0.00
1996	39.73	50.89	9.38	0.00
1997	40.55	49.49	9.96	0.00
1998	41.37	48.09	10.54	0.00
1999	42.18	46.70	11.12	0.00
2000	43.00	45.30	11.70	0.00
2001	44.71	43.59	11.70	0.00
2002	46.42	41.88	11.70	0.00
2003	48.12	40.18	11.70	0.00
2004	48.61	39.69	11.70	0.00
2005	49.09	39.21	11.70	0.00
2006	50.74	37.53	11.70	0.03
2007	52.42	35.85	11.70	0.03
2008	54.06	34.17	11.70	0.07
2009	55.64	32.49	11.70	0.17
2010	57.20	30.74	11.70	0.36
2011	57.20	30.74	11.70	0.36
2012	57.20	30.74	11.70	0.36

Non dairy	Liquid systems	Solid storage	Pasture	Other
1986	34.56	58.84	6.60	0.00
1987	34.56	58.84	6.60	0.00
1988	34.56	58.84	6.60	0.00
1989	34.56	58.84	6.60	0.00
1990	34.56	58.84	6.60	0.00
1991	35.41	57.49	7.10	0.00
1992	36.25	56.14	7.61	0.00
1993	37.10	54.79	8.12	0.00
1994	37.94	53.43	8.62	0.00
1995	38.79	52.08	9.13	0.00
1996	39.63	50.73	9.63	0.00
1997	40.48	49.38	10.15	0.00
1998	41.32	48.02	10.66	0.00
1999	42.16	46.66	11.18	0.00
2000	43.00	45.30	11.70	0.00
2001	44.71	43.59	11.70	0.00
2002	46.42	41.88	11.70	0.00
2003	48.12	40.18	11.70	0.00
2004	48.61	39.69	11.70	0.00
2005	49.09	39.21	11.70	0.00
2006	50.74	37.53	11.70	0.03
2007	52.42	35.85	11.70	0.03
2008	54.06	34.17	11.70	0.07
2009	55.64	32.49	11.70	0.17
2010	57.20	30.74	11.70	0.36
2011	57.20	30.74	11.70	0.36
2012	57.20	30.74	11.70	0.36

Allocation - swine and poultry

Swine	Anaerobic lagoon	Liquid systems	Solid storage	Other
1986	24.83	26.38	48.79	0.00
1987	26.20	26.64	47.16	0.00
1988	27.21	24.84	47.95	0.00
1989	26.53	25.93	47.54	0.00
1990	27.36	28.07	44.57	0.00
1991	28.09	25.01	46.89	0.00
1992	24.94	34.49	40.57	0.00
1993	24.44	35.95	39.61	0.00
1994	25.11	35.46	39.42	0.00
1995	14.81	35.06	48.48	1.65
1996	15.02	34.15	49.16	1.67
1997	15.08	36.57	46.67	1.68
1998	15.53	37.43	45.31	1.73
1999	6.39	40.13	48.37	5.11
2000	5.00	50.26	40.73	4.00
2001	5.30	49.37	41.09	4.24
2002	4.62	53.56	38.12	3.70
2003	4.62	54.21	37.47	3.70
2004	4.62	54.30	37.38	3.70
2005	4.62	54.38	37.30	3.70
2006	3.47	54.35	31.71	10.47
2007	3.36	54.57	30.01	12.05
2008	2.95	54.97	27.15	14.93
2009	3.15	56.38	26.68	13.79
2010	0.00	60.86	26.01	13.13
2011	0.00	62.08	24.75	13.17
2012	0.00	63.30	23.49	13.21

Poultry	Solid storage	Other
1986	81.98	18.02
1987	81.38	18.62
1988	81.89	18.11
1989	82.36	17.64
1990	82.00	18.00
1991	81.76	18.24
1992	80.05	19.95
1993	77.50	22.50
1994	76.18	23.82
1995	74.80	25.20
1996	78.27	21.73
1997	81.16	18.84
1998	80.16	19.84
1999	78.93	21.07
2000	77.39	22.61
2001	79.81	20.19
2002	80.04	19.96
2003	79.34	20.66
2004	77.06	22.94
2005	74.38	25.62
2006	72.53	27.47
2007	77.98	22.02
2008	77.42	22.58
2009	77.65	22.35
2010	75.58	24.42
2011	74.45	25.55
2012	82.25	17.75

3.b Other detailed methodological descriptions for LULUCF

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

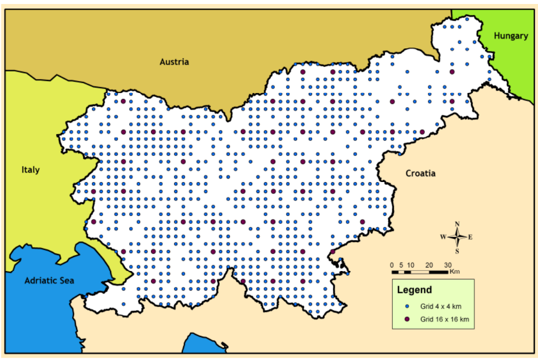

Figure 1: Arrangement of NFI 2007 sample plots on 4 x 4 km sample grid (●) and 16 x 16 km sample grid (●)

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.

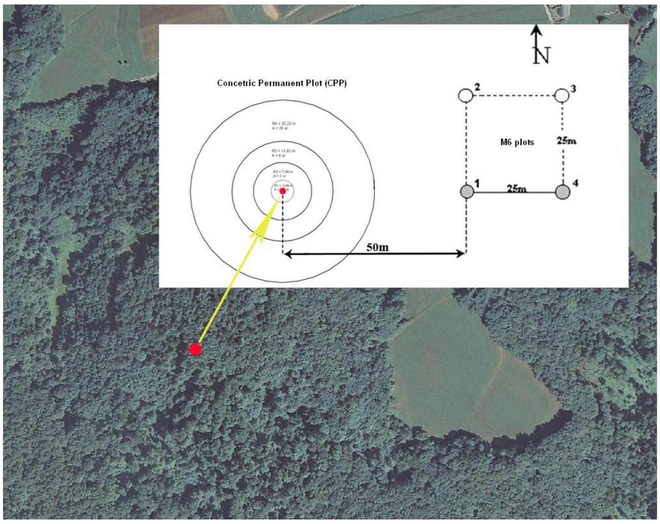

Figure 2: Scheme of CPP (on 16 x 16 km grid – CPP + all four M6 plots; on 4 x 4 grid – CPP + M6 plots nr. 1 and 4)

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.

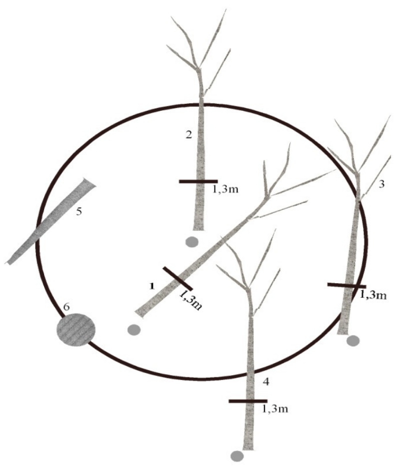

Figure 3: Examples of laying dead trees and stumps

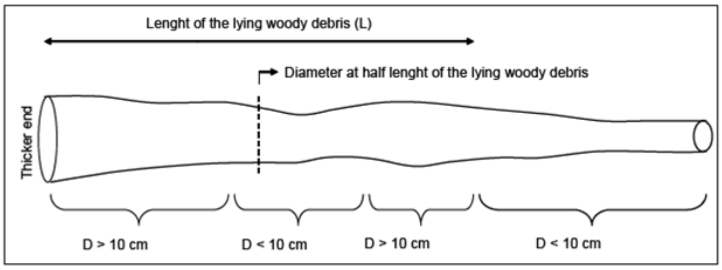

Figure 4: Example of a larger deadwood piece (length is measured from the thicker end to the thinnest end with D ≥ 10 cm)

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

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

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

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

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

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

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

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

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.

National Forest Inventory 2012 (FECS 2012)

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 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)

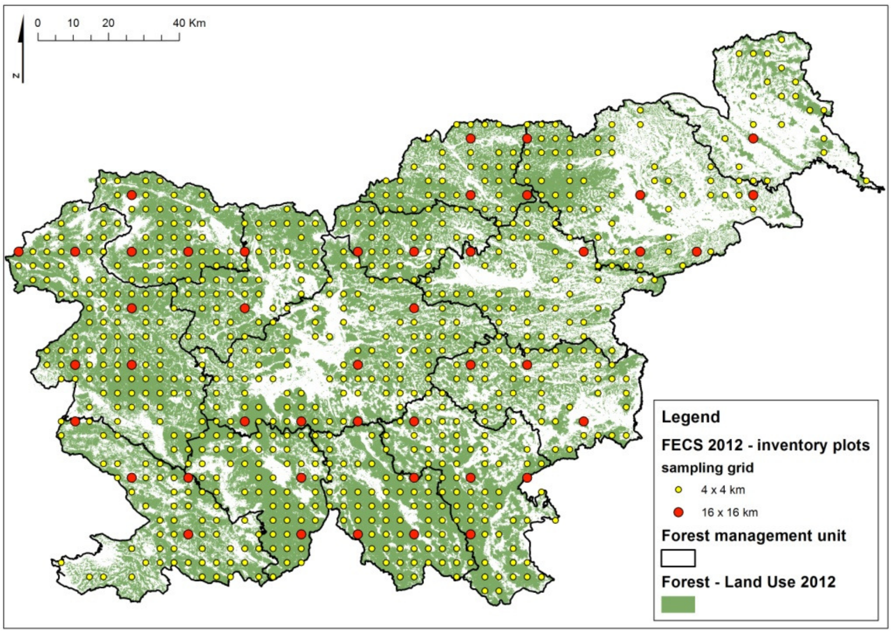

Figure 1: Plot locations of FECS 2012 on systematic grid of 4x4 km and 16x16 km.

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 %)

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.

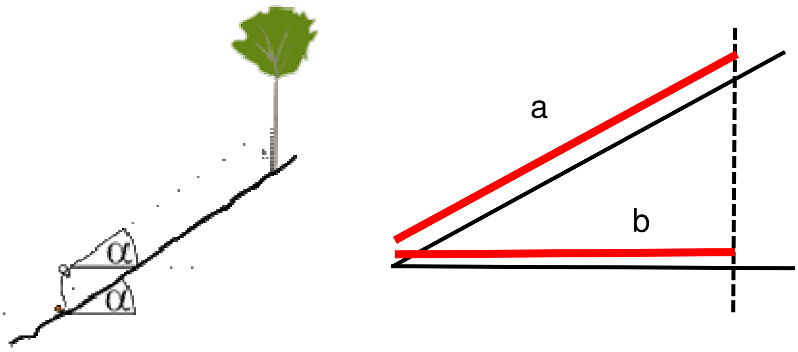

Figure 4: Scheme of measuring the slope of the terrain and vertical (a) and horizontal (b) distance to the tree.

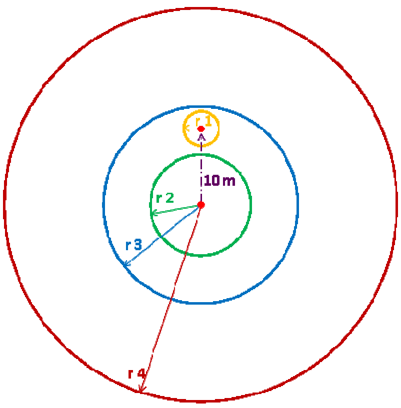

Figure 5: Plot division by different sub-plot radius.

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.

4 Methods of quality assurance and quality control of CCP data

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.

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.)

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

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.

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.

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.

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 ($D_{1,3}$).

4.3.2 Increment DH

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

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.

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.

4.3.2.1.3 Results

4.3.2.1.3.1 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

4.3.3 Deadwood

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.

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 lenth) 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.