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LULUCF and KP-LULUCF - Comparison of deforestation data

Final report

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LULUCF and KP-LULUCF - Comparison

Content

Annexe

Deforestation AREA85-AREA97: *DiffKpUnfccc_AREA85AREA97_V03_R00.xlsx*
Deforestation AREA97-AREA09: *DiffKpUnfccc_AREA97AREA09_V03_R00.xlsx*
Deforestation AREA85-AREA09: *DiffKpUnfccc_AREA85AREA09_V03_R00.xlsx*

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1 Introduction

A land-use change from a forest to a non-forest land type or deforestation is a relevant process under both the United Nations Framework Convention on Climate Change (UNFCCC; UN 1992[1]) and its Kyoto protocol (KP; UN 1998[2]). Deforestation corresponds to a change from forest land to another land type. Definitions for a land-use change from a forest to a non-forest land type and deforestation respectively differ between the UNFCCC and KP.

In Switzerland, land-use changes from a forest to a non-forest land type or deforestations are calculated according to the definition of UNFCCC and KP within the framework of the Greenhouse Gas Inventory (GHGI, latest report FOEN 2012[3]). All reported calculations are based on the Swiss Land Use Statistics following a standardized method (Mathys 2010[4]). Hence, quantification of land-use changes and deforestation relevant for the UNFCCC and KP are available.

To improve the quality of the reported values further analyses were initiated to compare the quantification as well as the spatial and temporal distribution of reported values between UNFCCC and KP (IPCC 2003[5], Chapter 4.2.6.2.1).

Goals of this study on land-use change and deforestation were therefore

1. to quantify their differences between UNFCCC and KP,
2. to assess their spatial distribution and
3. to assess their temporal distribution.

This study was carried out within the framework of GHGI submission 2013.

[1] United Nations (1992). United Nations Framework on Convention on Climate Change.
[2] United Nations (1998). Kyoto Protocol to the United Nations Framework Convention on Climate Change
[3] FOEN (2012). Switzerland's Greenhouse Gas Inventory - 1990-2010. National Inventory Report 2012 including reporting elements under the Kyoto Protocol. Submission of 13 April 2012.
[4] Mathys (2010). Deforestation under the Kyoto Protocol - Documentation of implementation. By order of FOEN.
[5] IPCC (2003). Good Practice Guidance for Land Use, Land-Use Change and Forestry.

2 Methods

All analyses were carried out within the data and methodological framework of GHGI submission 2013.

Data source was the Swiss Land Use Statistics (AREA) of the Federal Statistical Office (FSO). The Swiss Land Use Statistics is a country-wide sampling scheme with regular 100 meter spacing between sample plots. Each sample plot is attributed with a land use and land cover type. These land use and land cover types were combined to produce 18 combination classes (CC) relevant for the GHGI (Table 1). Consequently, each sample plot is finally attributed with 1 out of 18 combination classes.

Table 1 GHG combination categories

Main category	Combination category number	Combination category name
Forest Land	11	Afforestations
	12	Managed forest
	13	Unproductive forest
Cropland	21	Cropland
Grassland	31	Permanent grassland
	32	Shrub vegetation
	33	Vineyards, Low-stem Orchards, Tree nurseries
	34	Copse
	35	Orchards
	36	Stony grassland
	37	Unproductive grassland
Wetlands	41	Surface waters
	42	Unproductive wetland
Settlements	51	Buildings and construction
	52	Herbaceous biomass in settlements
	53	Shrubs in settlements
	54	Trees in settlements
Other land	61	Other land

Data acquisition of the FSO is currently still in progress and carried out at the same time for three consecutive inventories that are based on aerial images from three time periods. AREA85 is based on aerial images 1979-1985, AREA97 is based on aerial images 1990-1998 and AREA 09 is based on aerial images 2004-2009. Corresponding CC are labelled CC85, CC97, and CC09 respectively.

As a consequence, for GHGI submission 2013 the FSO provided 3'441'282 sample plots (83 % of Switzerland) for three inventories (AREA85, AREA97, AREA09) attributed with the 18 combination classes (Figure 1).

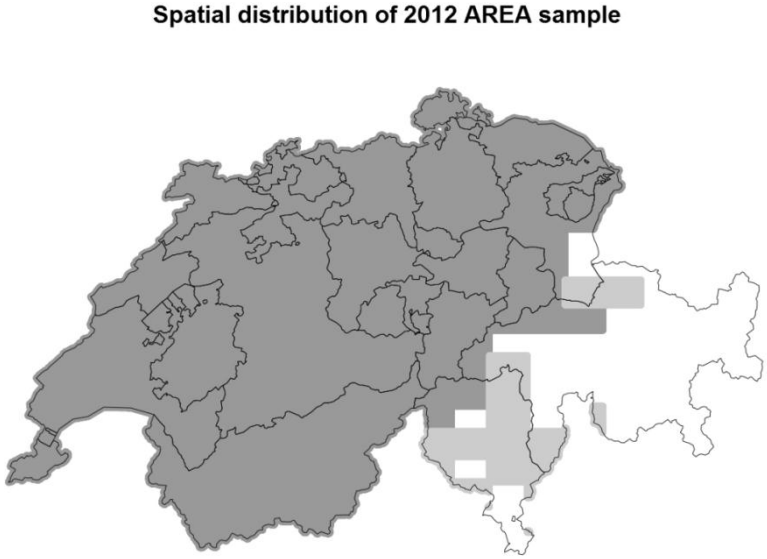

Figure 1 Spatial distribution of verified (dark grey) and non-verified (light grey) FSO sample plots used

Land-use changes from a forest to a non-forest CC according to UNFCCC are calculated based on samples that are converted from a forest CC (11 Afforestations, 12 Managed Forest, 13 Unproductive Forest) to any other CC (Könitzer & Mathys *in prep.*[6]). In other words, land-use changes are calculated based on two consecutive inventories (AREA85-AREA97, AREA97-AREA09, AREA85-AREA09).

Deforestation according to KP is calculated based on UNFCCC land-use changes from a forest to a non-forest CC with additional criteria applied (Mathys 2010[7]).

All statistical analyses and visualisations were performed in R version 2.14.1 (R Development Core Team 2011[8]).

[6] Könitzer, Ch. & Mathys, L. (*in prep.*). LULUCF, Submission April 2013. Interne Dokumentation Sigmaplan. By order of FOEN.

[7] Mathys (2010). Deforestation under the Kyoto Protocol - Documentation of implementation. By order of FOEN.

[8] R Development Core Team (2011). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org

3 Results and Discussion

3.1 Differences between UNFCCC and KP

Total sample population delivered by the Federal Statistical Office (OFS) was 3'441'282 (Table 2).

Land-use changes from a forest to a non-forest CC according to UNFCCC occurred on 8'247 sample plots between AREA85-AREA97 (0.2 % of sample population), on 9'711 sample plots between AREA97-AREA09 (0.3 % of sample population) and on 15'247 sample plots between AREA85-AREA09 (0.4 % of sample population).

Deforestation according to Kyoto occurred on 3'256 sample plots between AREA85-AREA97 (0.1 % of sample population), on 3'139 sample plots between AREA97-AREA09 (0.1 % of sample population) and on 5'647 sample plots between AREA85-AREA09 (0.2 % of sample population).

Table 2 Deforestation summary

Reference	Start inventory	End inventory	Type	Samples
OFS	AREA85	AREA97	all	3'441'282
UNFCCC	AREA85	AREA97	conversion to non-forest CC	8'247
KYOTO	AREA85	AREA97	deforestation	3'256
OFS	AREA97	AREA09	all	3'441'282
UNFCCC	AREA97	AREA09	conversion to non-forest CC	9'711
KYOTO	AREA97	AREA09	deforestation	3'139
OFS	AREA85	AREA09	all	3'441'282
UNFCCC	AREA85	AREA09	conversion to non-forest CC	15'247
KYOTO	AREA85	AREA09	deforestation	5'647

The ratio between land-use changes from a forest to a non-forest CC according to UNFCCC and deforestation according to Kyoto are between 2.5 and 3.1. This ratio is determined by the method used to calculate Kyoto deforestation (see Mathys 2010[4]), where Kyoto deforestation corresponds to a generated proportion of UNFCCC land-use changes from a forest to a non-forest CC.

Out of all UNFCCC land-use changes between AREA85-AREA97 86 % are also considered changes in the longer term between AREA85-AREA09 (Figure 2). The rest of the sample plots have land-use changes between AREA85-AREA97, and are classified as forest again in AREA09; i.e. short-term land use changes.

Out of all Kyoto deforestations between AREA85-AREA97 85 % are also considered deforestation in the longer term between AREA85-AREA09 (Figure 3). The rest of the sample plots have deforestation between AREA85-AREA97, and are classified as forest again in AREA09; i.e. short-term deforestation.

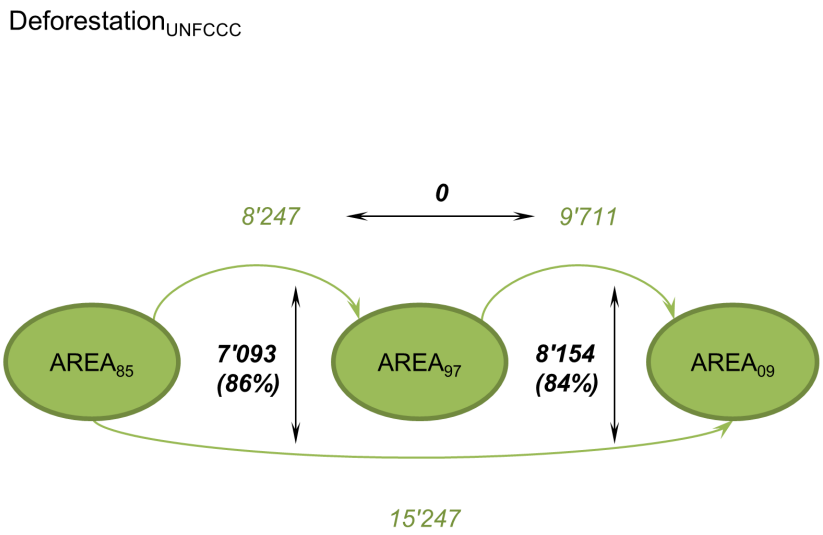

Figure 2 Changes according to UNFCCC between 2 consecutive AREA inventories (green) and proportion of short-term changes to long-term changes (black)

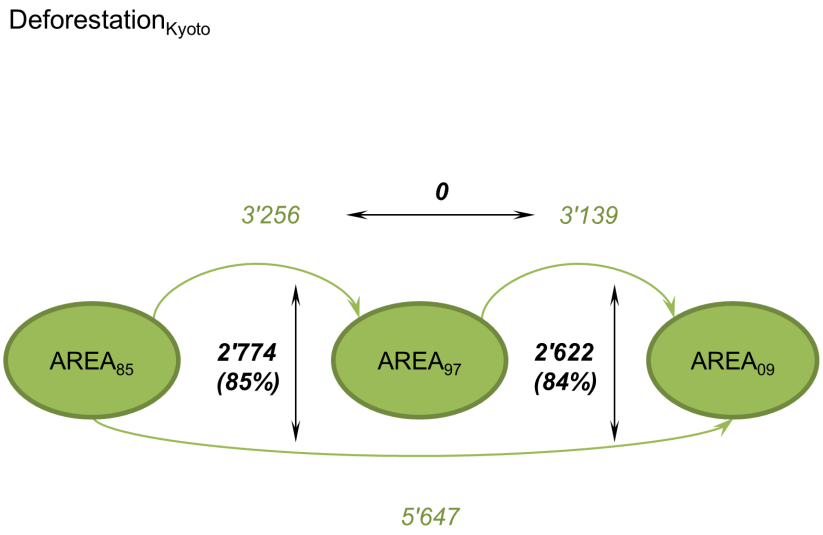

Figure 3 Changes according to Kyoto between 2 consecutive AREA inventories (green) and proportion of short-term changes to long-term changes (black)

End CC97 classes for long-term land-use changes, i.e. deforestation between AREA85-AREA97 and not again forest in AREA09, are listed according to UNFCCC (Table 3) and Kyoto (Table 4).

End CC97 classes for short-term land-use changes, i.e. deforestation between AREA85-AREA97 and again forest in AREA09, are listed according to UNFCCC (Table 5) and Kyoto (Table 6).

Table 3 Long-term UNFCCC land-use change forest to non-forest CC

Reference	Original period	Compare period	Type	CC85	CC97	Samples
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	11	21	1
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	11	31	5
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	11	32	4
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	11	34	2
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	11	51	4
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	21	60
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	31	1266
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	32	505
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	33	57
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	34	680
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	36	98
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	37	147
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	41	104
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	42	77
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	51	1144
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	52	233
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	53	81
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	54	152
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	12	61	404
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	31	1369
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	32	240
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	33	1
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	34	263
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	36	22
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	37	15
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	41	12
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	42	14
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	51	52
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	52	4
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	53	1
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	54	10
UNFCCC	AREA85-AREA97	AREA85-AREA09	same	13	61	66

Table 4 Long-term Kyoto deforestation

Reference	Original period	Compare period	Type	CC85	CC97	Samples
Kyoto	AREA85-AREA97	AREA85-AREA09	same	11	31	5
Kyoto	AREA85-AREA97	AREA85-AREA09	same	11	51	3
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	21	50
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	31	706
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	32	74
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	33	50
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	36	13
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	37	21
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	41	80
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	42	4
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	51	1081
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	52	219
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	53	77
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	54	140
Kyoto	AREA85-AREA97	AREA85-AREA09	same	12	61	50
Kyoto	AREA85-AREA97	AREA85-AREA09	same	13	31	65
Kyoto	AREA85-AREA97	AREA85-AREA09	same	13	32	57
Kyoto	AREA85-AREA97	AREA85-AREA09	same	13	33	1
Kyoto	AREA85-AREA97	AREA85-AREA09	same	13	36	2
Kyoto	AREA85-AREA97	AREA85-AREA09	same	13	37	1
Kyoto	AREA85-AREA97	AREA85-AREA09	same	13	41	8
Kyoto	AREA85-AREA97	AREA85-AREA09	same	13	51	50
Kyoto	AREA85-AREA97	AREA85-AREA09	same	13	52	4
Kyoto	AREA85-AREA97	AREA85-AREA09	same	13	53	1
Kyoto	AREA85-AREA97	AREA85-AREA09	same	13	54	10
Kyoto	AREA85-AREA97	AREA85-AREA09	same	13	61	2

Table 5 Short-term UNFCCC land-use change forest to non-forest CC

Reference	Original period	Compare period	Type	CC85	CC97	Samples
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	11	34	1
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	11	51	1
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	11	52	1
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	11	53	1
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	11	61	1
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	31	60
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	32	317
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	34	145
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	36	21
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	37	16
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	41	11
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	42	2
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	51	101
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	52	34
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	53	21
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	54	8
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	12	61	97
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	13	31	48
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	13	32	111
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	13	34	129
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	13	36	10
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	13	37	1
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	13	51	2
UNFCCC	AREA85-AREA97	AREA85-AREA09	different	13	61	15

Table 6 Short-term Kyoto deforestation

Reference	Original period	Compare period	Type	CC85	CC97	Samples
Kyoto	AREA85-AREA97	AREA85-AREA09	different	11	51	2
Kyoto	AREA85-AREA97	AREA85-AREA09	different	11	52	1
Kyoto	AREA85-AREA97	AREA85-AREA09	different	11	53	1
Kyoto	AREA85-AREA97	AREA85-AREA09	different	11	61	1
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	31	60
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	32	49
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	33	3
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	36	12
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	37	7
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	41	34
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	42	1
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	51	119
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	52	38
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	53	23
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	54	10
Kyoto	AREA85-AREA97	AREA85-AREA09	different	12	61	75
Kyoto	AREA85-AREA97	AREA85-AREA09	different	13	31	8
Kyoto	AREA85-AREA97	AREA85-AREA09	different	13	32	18
Kyoto	AREA85-AREA97	AREA85-AREA09	different	13	36	4
Kyoto	AREA85-AREA97	AREA85-AREA09	different	13	41	4
Kyoto	AREA85-AREA97	AREA85-AREA09	different	13	51	4
Kyoto	AREA85-AREA97	AREA85-AREA09	different	13	61	8

3.2 Spatial distribution

Land-use changes from a forest to a non-forest CC according to UNFCCC within the sample population mostly occurs in the Jura mountain range, the Prealps, as well as medium elevation of the inner and southern Alpine area (Figure 4). In the Jura mountain range long-term changes, i.e. land-use changes between AREA85-AREA97 and not again forest in AREA09, are more frequent than short-term changes, i.e. land-use changes between AREA85-AREA97 and again forest in AREA09. The other areas do not show a distinct pattern.

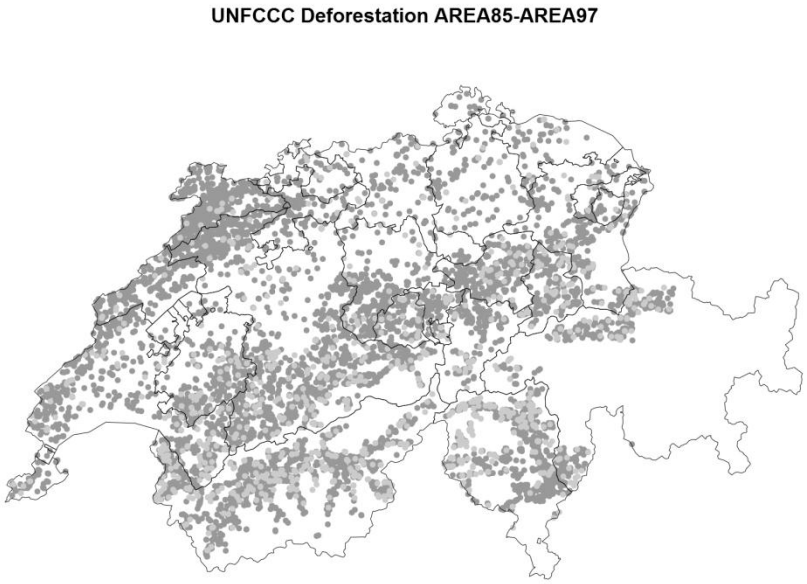

Figure 4 Spatial distribution of long-term (dark grey) and short-term (light grey) UNFCCC deforestation sample plots

Deforestation according to Kyoto within the sample population occurs more evenly distributed (Figure 5). Long-term and short-term deforestation show a similar spatial pattern.

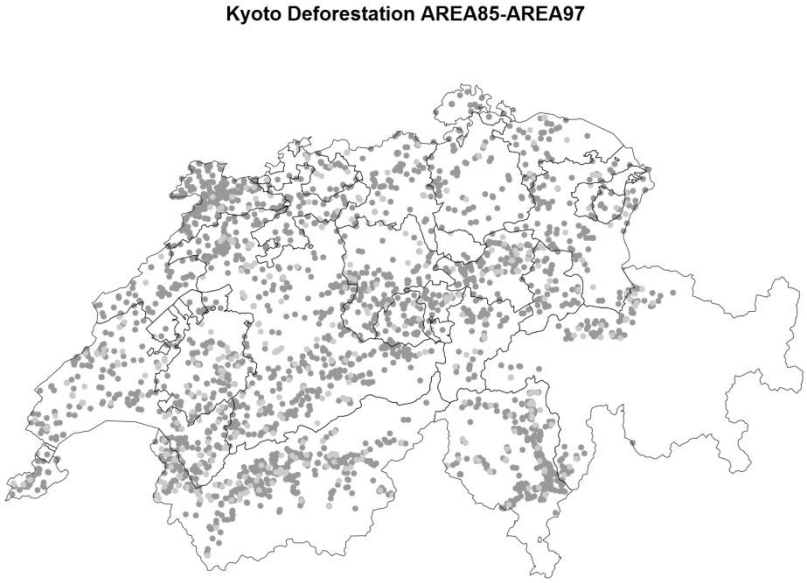

Figure 5 Spatial distribution of long-term (dark grey) and short-term (light grey) Kyoto deforestation sample plots

3.3 Temporal distribution

Land-use changes from a forest to a non-forest CC between AREA85-AREA97 do occur (chapter 3.1). A large proportion of the sample plots, 86 % for UNFCCC and 85 % for Kyoto respectively, remain deforested.

Long-term deforestation between AREA85-AREA97 and their corresponding non-forest combination classes in AREA09 are provided for UNFCCC (Figure 6) and Kyoto (Figure 7).

Short-term deforestation between AREA85-AREA97 and their corresponding forest combination classes in AREA09 are provided for UNFCCC (Figure 8) and Kyoto (Figure 9).

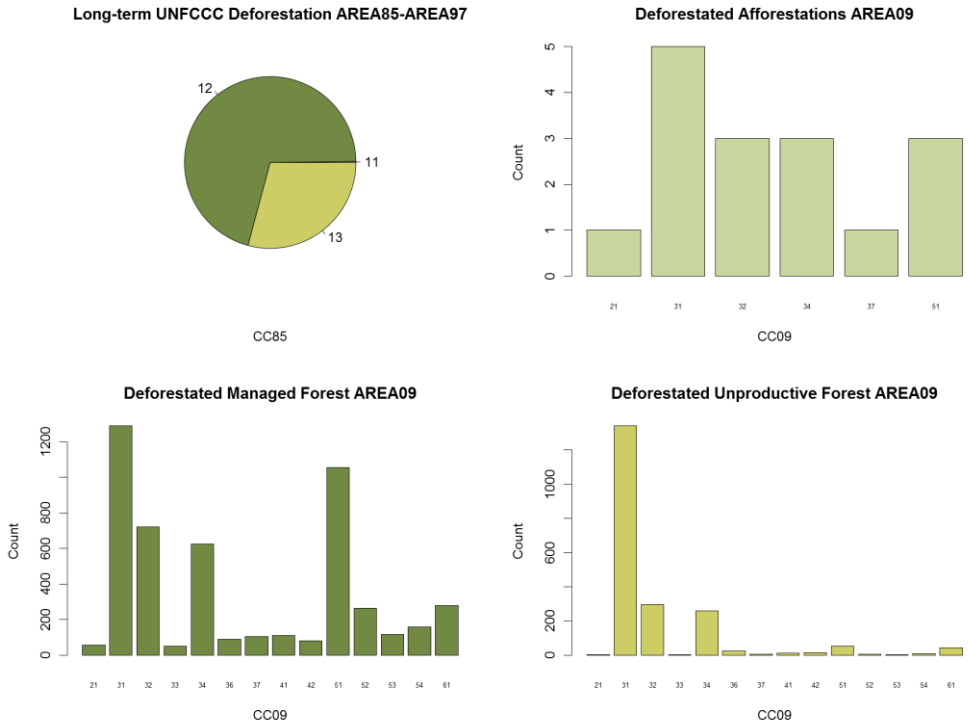

Figure 6 Long-term UNFCCC deforestation (t. l.) and corresponding CC in AREA09 (t. r., l.)

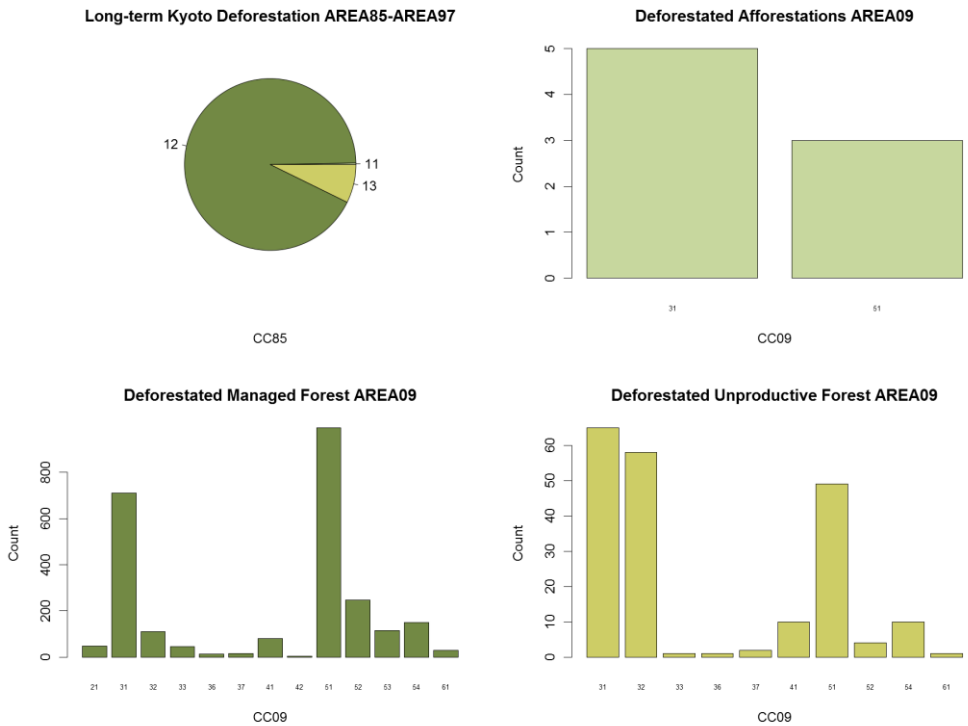

Figure 7 Long-term Kyoto deforestation (t. l.) and corresponding CC in AREA09 (t. r., l.)

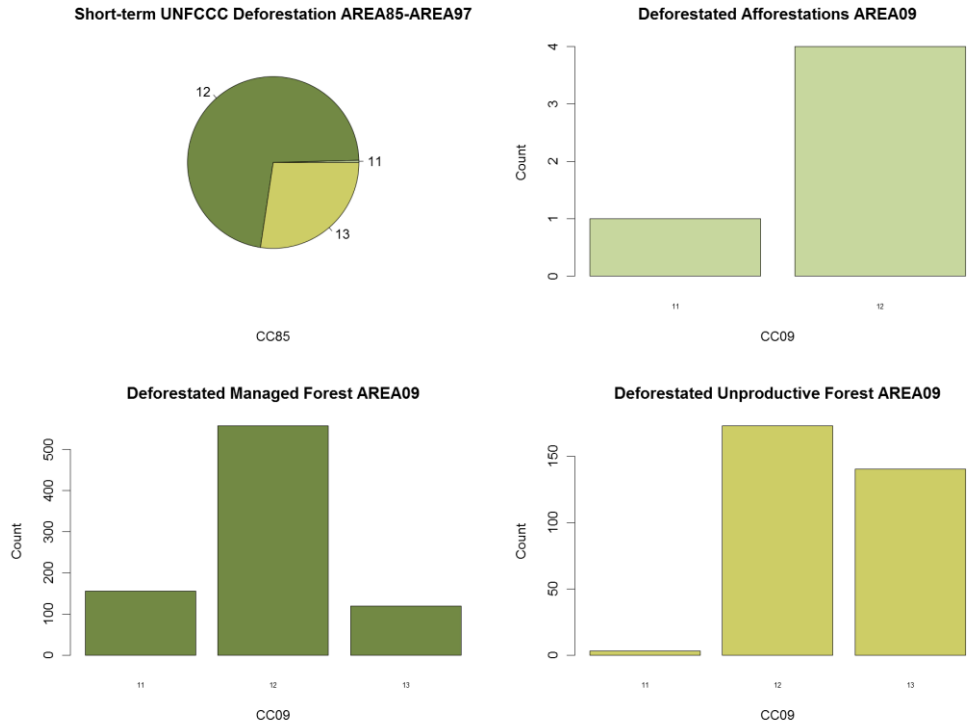

Figure 8 Short-term UNFCCC deforestation (t. l.) and corresponding CC in AREA09 (t. r., l.)

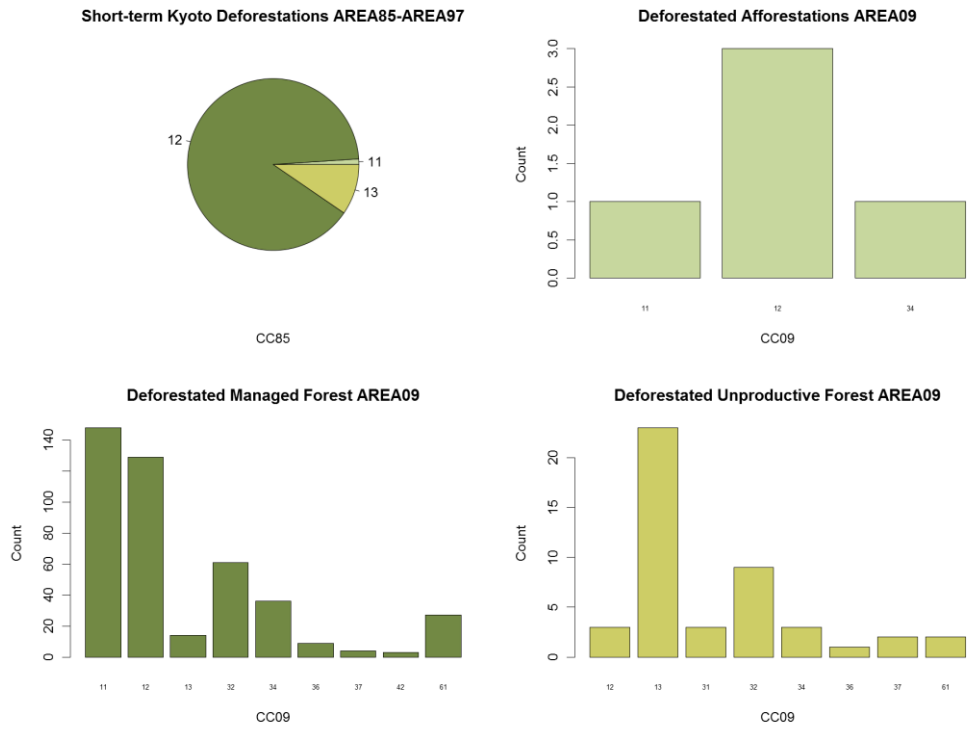

Figure 9 Short-term Kyoto deforestation (t. l.) and corresponding CC in AREA09 (t. r., l.)

4 Conclusions

Land use changes from a forest to a non-forest CC and deforestation occur in Switzerland. However, the proportion is very small compared to other landscape changes relevant for the GHGI (see table 7-9 in FOEN 2012[3]). Deforestations mostly remain for at least two consecutive AREA inventories (i.e. 12 years). Out of these long-term deforestations a large proportion develops either to an agricultural or construction area, which is often subject to human activities.