

„Tracking land-use changes from heterogeneous spatial data as a tool for biodiversity and greenhouse gas monitoring in the nature park Drömling“

by Johanna Untenecker^{1,2}, Bärbel Tiemeyer¹, Annette Freibauer¹, Andreas Laggner¹, Fred Braumann³ & Juerg Luterbacher²

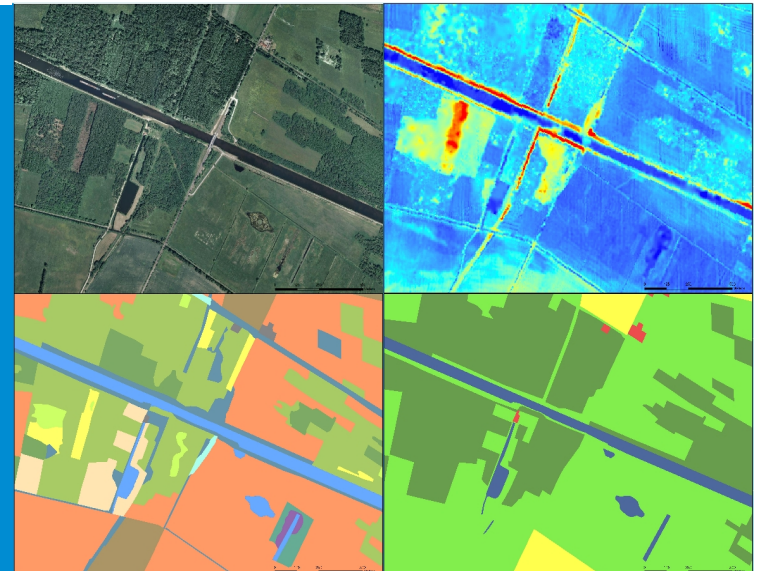
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S5

Environmental monitoring to quantify ecosystem services



Introduction

- Peatlands are important habitats for strongly specialized and endangered species
- Drained peatlands are hotspots of greenhouse gas (GHG) emissions
- Land use change (on peatlands/ organic soils) has a large influence on biodiversity and GHG emissions

Objectives

- Detecting changes in land-use and land-use intensity at adequate spatial (>1 hectare) and thematic resolution as proxy for:
 - Biodiversity & GHG emissionson organic soils for large areas (federal states)

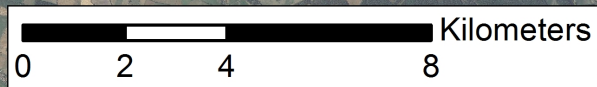
12,758 ha organic soils



Legend

- Dip Well
- ▭ Nature Park
- ▬ State Border
- Histic Gleysol
- Histosol

Sources:
Dip Wells: Naturparkverwaltung Drömling 2013
Park Border: Naturparkverwaltung Drömling 2013
Soils (GÜK200): BGR (without year)
Basemap Germany: ESRI 2013
Orthophoto: Geodatenzentrum 2013



- 2 types of land-use data sets available:
 - CIR → color-infrared aerial photos (processed)
 - 1992, 2005
 - ATKIS Basic-DLM → digital landscape model
 - 2000, 2008, 2012

Data

	CIR	DLM
Spatial Resolution	< 1:10.000	< 1:25.000
Temporal Accuracy	11 weeks	5 years to 3 months
No. of land use classes	<15	>25

CIR: LVerGeo - Landesamt für Vermessung und Geoinformation Sachsen-Anhalt

DLM: BKG - Federal Agency for Cartography and Geodesy

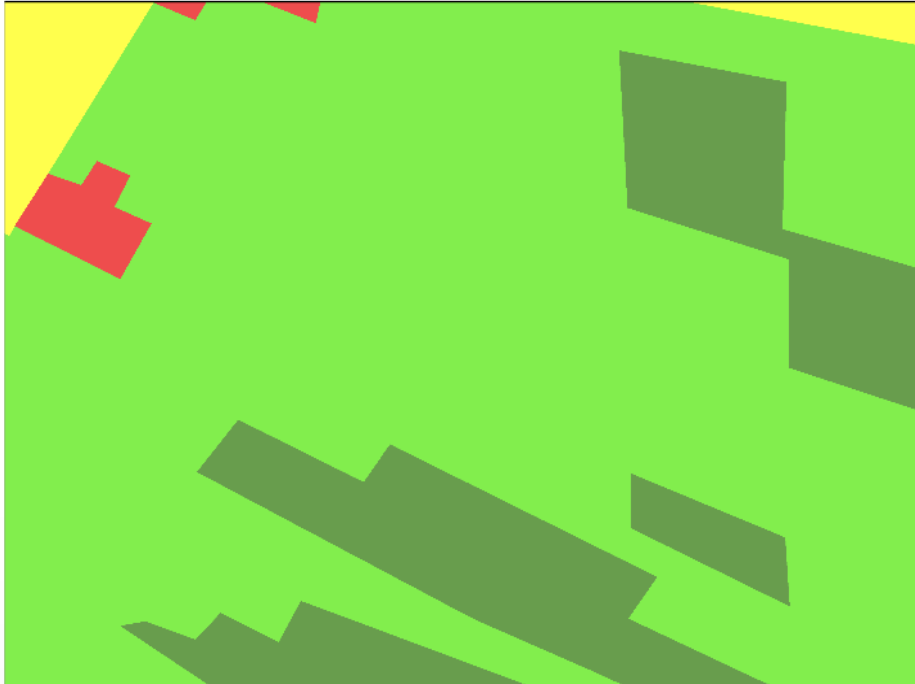
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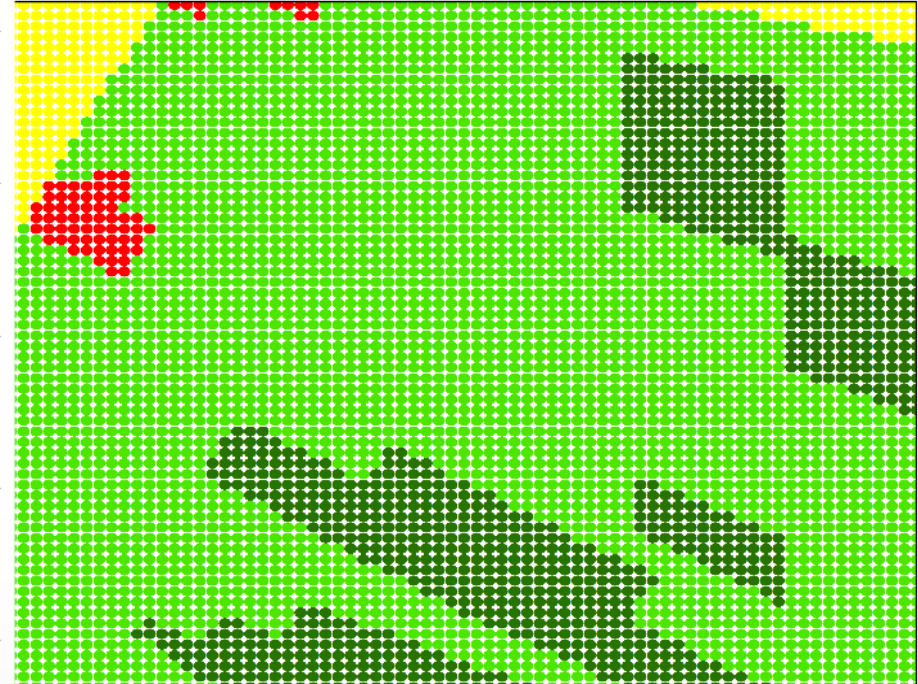
DLM: BKG - Federal Agency for Cartography and Geodesy

10m - grid



ATKIS Basis-DLM 2008

Source: BKG



ATKIS Basis-DLM 2008 (10m grid)

Source: BKG

→ Each grid point represents **0.01 ha**

Translation of CIR and DLM

- Attempt for a common legend
 - Using CIR 2005 & DLM 2008
 - not possible → Soft Translation Key

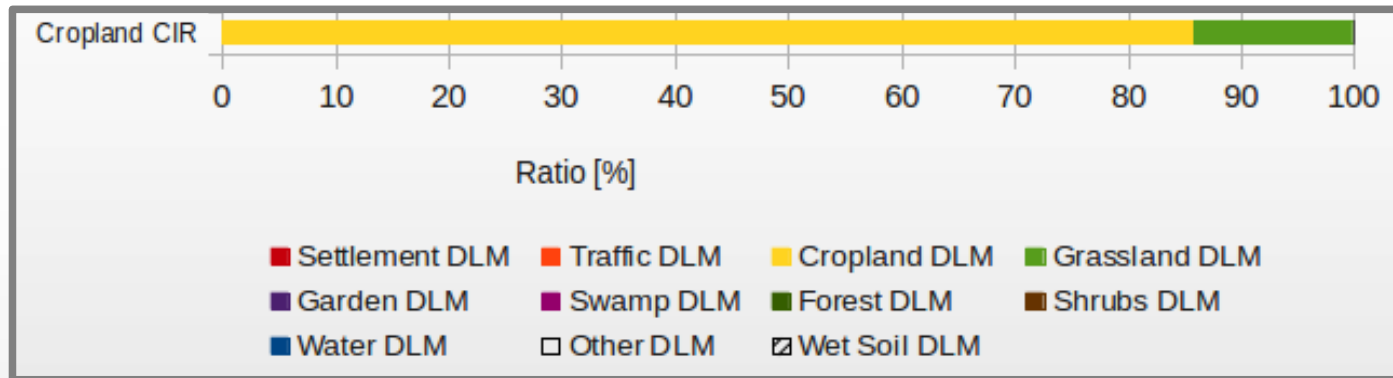
Soft Translation Key

		DLM 2008								
		Settlement	Traffic	Cropland	Grassland	...	Forest	Shrubs	Water	SUM
CIR 2005	Cropland	12		141029	22992		96	2	45	164181
	Settlement	1850	53	24	144		10		3	2084

		DLM 2008								
		Settlement	Traffic	Cropland	Grassland	...	Forest	Shrubs	Water	SUM
CIR 2005	Cropland	0.0		85.9	14.0		0.1	0.0	0.0	100
	Settlement	88.8	2.5	1.2	6.9		0.5		0.1	100

Soft Translation Key

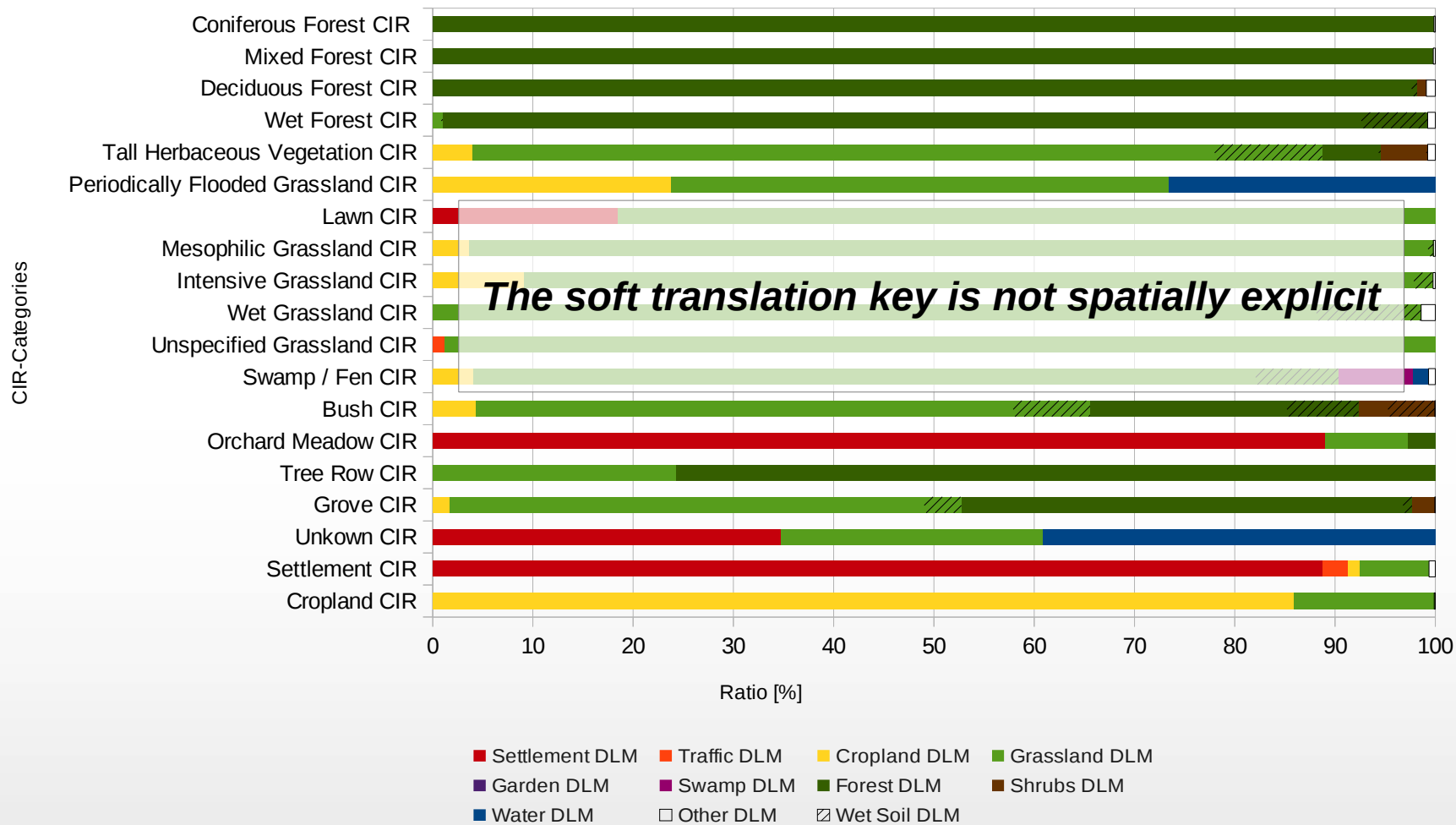
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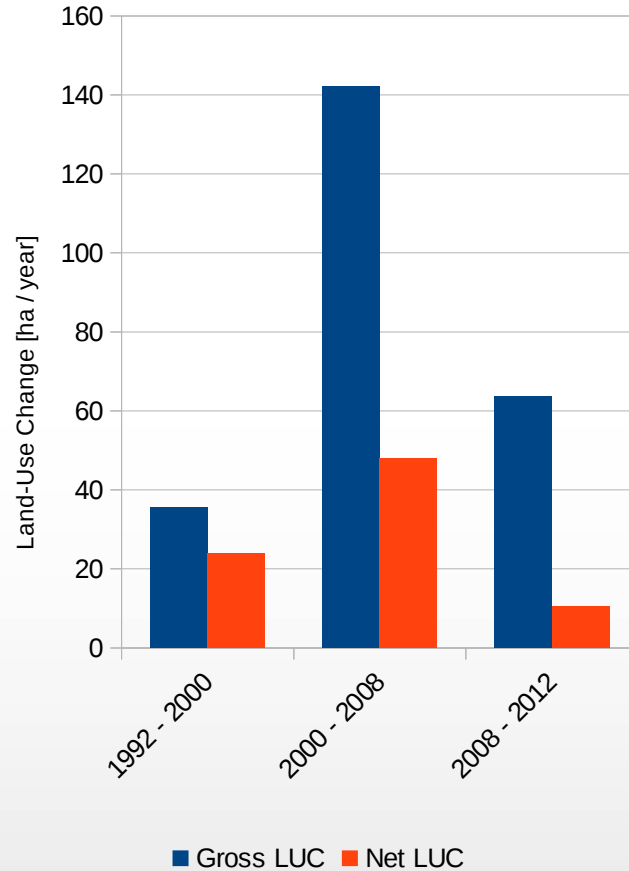
Methods



Methods

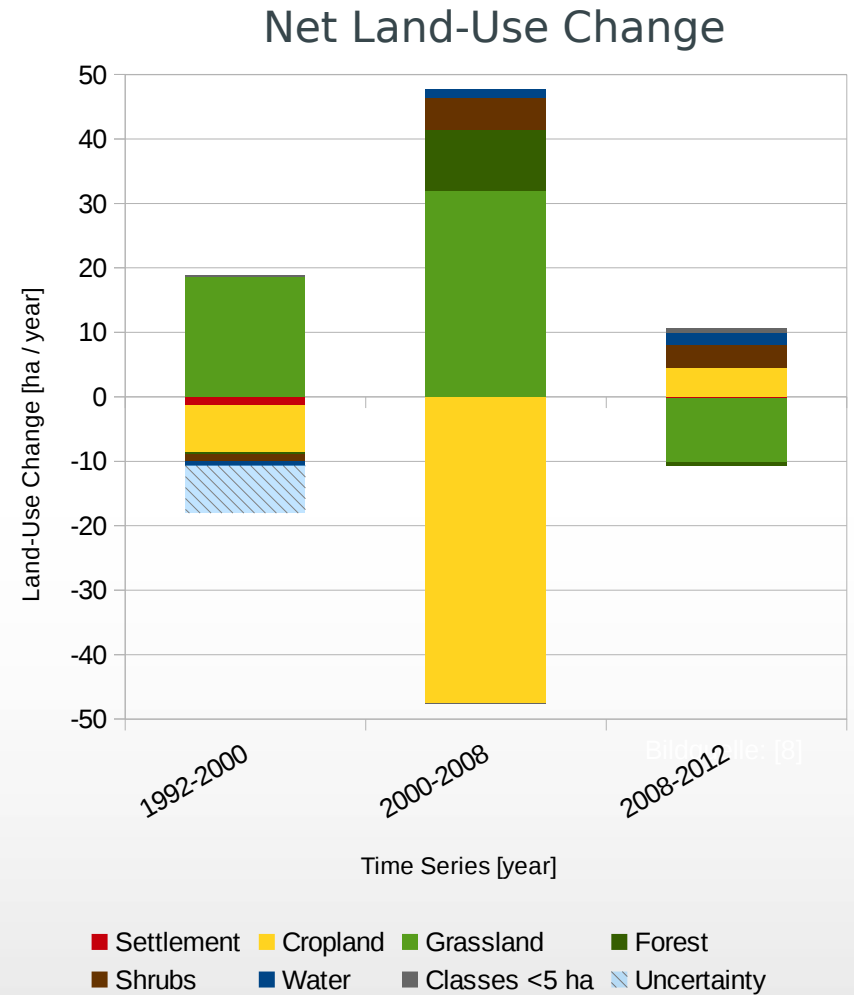
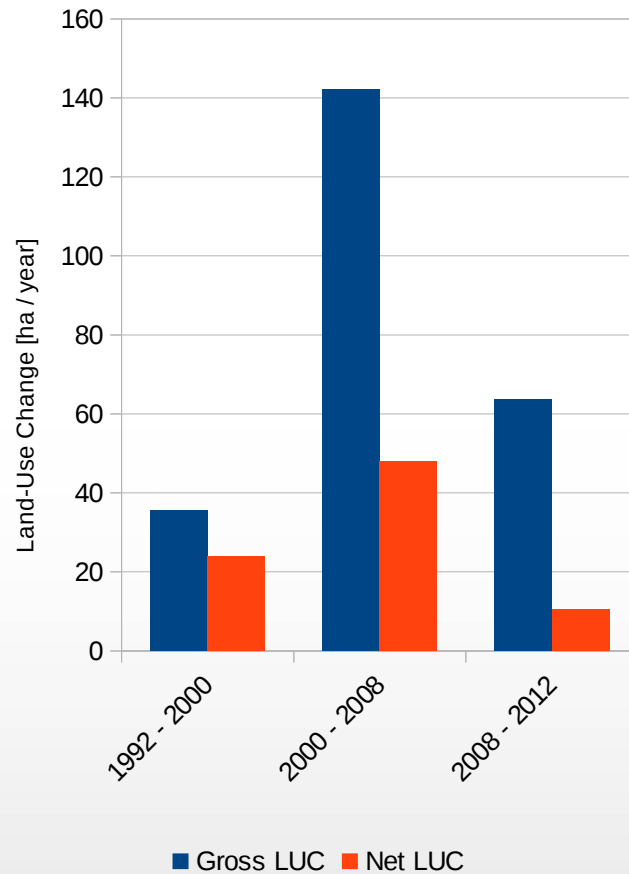


Land-use Change

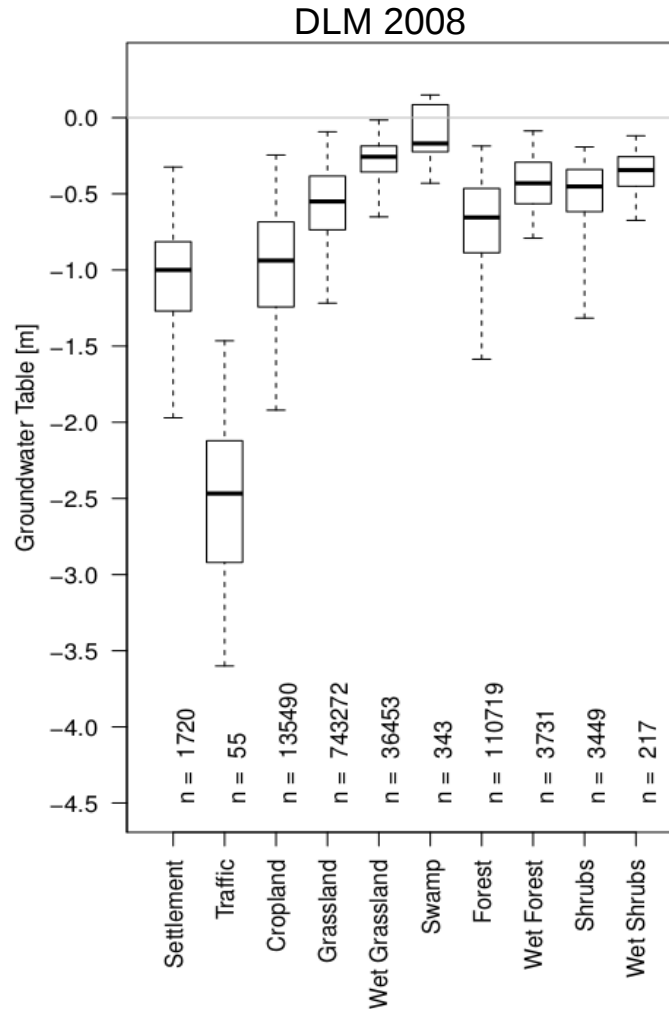


Bildquelle: [8]

Land-use Change

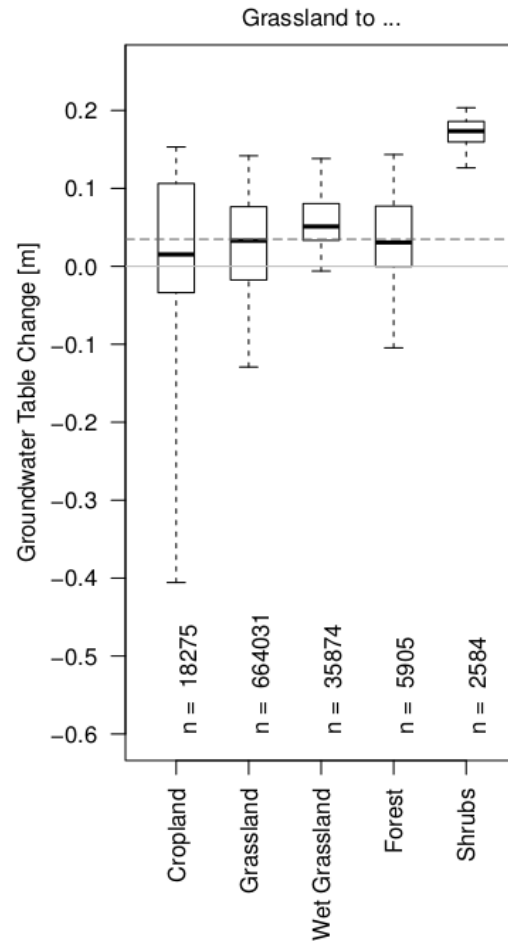


Groundwater Table and Land-Use



Groundwater table per land-use classification (90%) $n=1 \hat{=} 0.01$ ha

Change in Groundwater Table & LUC 2000 - 2008



Change in groundwater table (90%) of grassland in 2000 plotted as the land-use classes of 2008 (only areas >10ha, $n=1 \triangleq 0.01$ ha); solid grey line: land surface; dashed gray line: median of the land use class of 2000

CO₂-Emissions in 1992 and 2012

$$CO_2 - C_{on-site} = \sum_{c,n,d} (A * EF)_{c,n,d}$$

[IPCC Guidelines for National Greenhouse Gas Inventories of 2006 and the IPCC Wetlands Supplement of 2013]

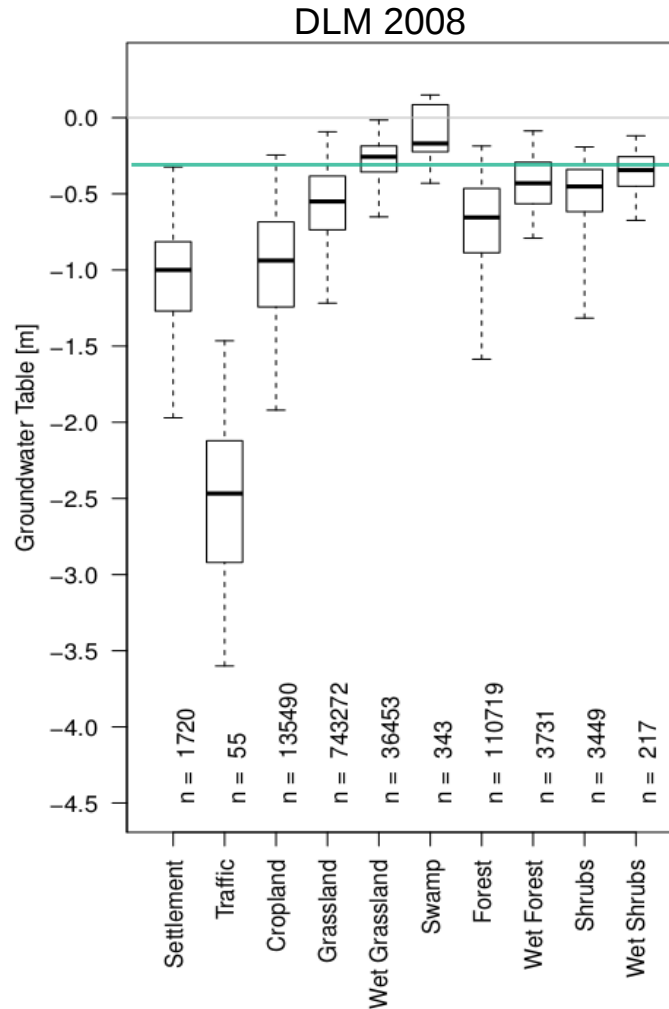
CO₂-C_{on-site} = Annual on-site CO₂-C emissions/removals in tons C yr⁻¹

A = Land area of drained organic soils in ha

EF = Emission factors in tons C ha⁻¹ yr⁻¹

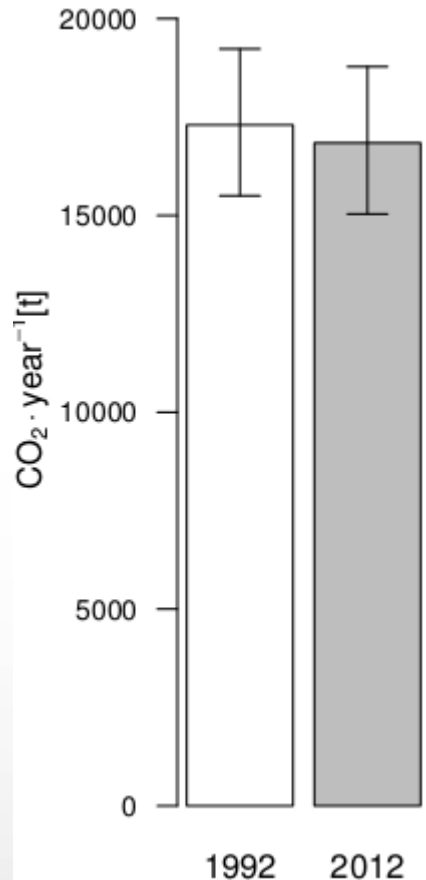
C: climate domain, N: nutrient status, D: drainage class

Groundwater Table and Land-Use



Groundwater table per land-use classification (90%) $n=1 \hat{=} 0.01$ ha

CO₂-Emissions in 1992 and 2012



- 1992: 17,298 t CO₂ year⁻¹,
- 2012: 16,842 t CO₂ year⁻¹
- Reduction of 2.6%

Conclusions

- The Soft Translation Key can be used for larger areas
- Nature Protection Efforts were detected and confirmed
- Moderately strong relation between groundwater table and land-use
 - → land-use can be used as a proxy for groundwater table, if available in good quality, but still a high uncertainty remains
- The reduction of CO₂ emissions due to rewetting encompassed 456 t year⁻¹ or 2.6% of the total emissions

Thank you for your attention!

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DLM2000											
CIR1992	Settlement DLM	Traffic DLM	Cropland DLM	Grassland DLM	Garden DLM	Swamp DLM	Forest DLM	Shrubs DLM	Unknown DLM	Water DLM	SUM
Cropland CIR	18	15	189662	43070	6		180		19		232970
Settlement CIR	1892	9	72	969			3				2945
Unkown CIR			82	1111			64		119		1376
Single Tree CIR				8							8
Grove CIR	6		359	2306			2173	24			4868
Hedge CIR	12			653			12				677
Tree Row CIR			45	5041			245				5331
Orchard Meadow CIR	54		12	46	2		1				115
Bush CIR	1		284	3714			491				4490
Swamp / Fen CIR			21	601		17	42				681
Unspecified Grassland CIR			118	1							119
Wet Grassland CIR	15		4224	221939			1600		30		227808
Intensive Grassland CIR	55		20498	243733	1		144		19	6	264456
Mesophile Grassland CIR	73		14007	336170			483	7			350740
Peat Land CIR				86							86
Tall Herbaceous Vegetation CIR	59		1670	26934			1717	41	211		30632
Wet Forest CIR				583		33	38664	3	7	6	39296
Deciduous Forest CIR			114	951			68782	65			69912
Mixed Forest CIR			4	62			3690				3756
Coniferous Forest CIR							1578				1578
SUM	2185	24	231172	887978	9	50	119869	140	405	12	1241844

- Validation:

CIR 1992 → CIR 2005 = CIR 1992 → DLM 2008

	DLM 2000													
CIR 1992	Settlement _{DLM}	Traffic _{DLM}	Cropland _{DLM}	Grassland _{DLM}	Garden _{DLM}	Swamp _{DLM}	Forest _{DLM}	Shrubs _{DLM}	Unkown _{DLM}	Water _{DLM}	Area [ha]	Uncertainty [%]	Land-use change per class [%]	Total land-use change [%]
Cropland _{CIR}	0.0	0.0	-4.5	4.5	0.0		0.1		0.0		2329.70	0.1	4.6	0.86
Settlement _{CIR}	-24.5	-2.2	1.3	26.0			0.1				29.45	0.6	27.2	0.06
Unkown _{CIR}	-34.8		6.0	54.7			4.7		8.6	-39.1	13.76	0.0	73.9	0.08
Single Tree_{CIR}											0.08			
Grove _{CIR}	0.1		5.6	-3.6			-0.4	-1.7			48.68	0.0	5.8	0.02
Hedge_{CIR}											6.77			
Tree Row_{CIR}			0.8	70.3			-71.1				53.31	0.0	0.0	0.00
Orchard Meadow _{CIR}	-42.1		10.4	31.8	1.7		-1.9				1.15	0.0	44.0	0.00
Bush _{CIR}	0.0		2.0	21.4			-15.8	-7.6			44.90	0.0	15.8	0.06
Swamp / Fen _{CIR}			-1.0	1.9		-4.9	6.2			-1.5	6.81	0.7	3.1	0.00
Unspecified Grassland _{CIR}		-1.2	99.2	-98.0							1.19	0.0	99.2	0.01
Wet Grassland _{CIR}	0.0		1.9	-1.2			0.7		0.0		2278.08	1.4	2.5	0.47
Intensive Grassland _{CIR}	0.0		-1.3	1.5	0.0		0.1		0.0	0.0	2644.56	0.2	1.5	0.33
Mesophilic Grassland _{CIR}	0.0		0.3	-0.3			0.1	0.0			3507.40	0.2	0.5	0.14
Peat Land_{CIR}											0.86			
Tall Herbaceous Vegetation _{CIR}	0.2		1.5	3.2			-0.3	-4.5			306.32	0.8	5.5	0.14
Wet Forest _{CIR}	0.0	0.0		0.5	0.0	0.1	0.2	0.0		0.0	392.96	0.8	0.7	0.02
Deciduous Forest _{CIR}	0.0	0.0	0.2	1.4	0.0	0.0	0.2	-0.8	0.7	0.0	699.12	0.9	1.7	0.09
Mixed Forest _{CIR}	0.0	0.0	0.1	1.7	0.0	0.0	-1.6	0.0	0.0	0.0	37.56	0.2	1.8	0.01
Coniferous Forest _{CIR}	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	15.78	0.1	0.1	0.00

Minimum	-1.43m
Maximum	1.39m
Mean Value	0.00m
Standard Deviation	0.17m

Land Use 2008	Change in Groundwater Table [m]
Settlement	+0.03
Traffic	-0.06
Cropland	-0.04
Grassland	+0.02
Wet Grassland	+0.06
Swamp	+0.11
Forest	+0.01
Wet Forest	+0.10
Shrubs	+0.14
Wet Shrubs	+0.07