Assessment of RDP impacts on Soil Organic Carbon and Soil Erosion on Arable Land in Austria

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Outline

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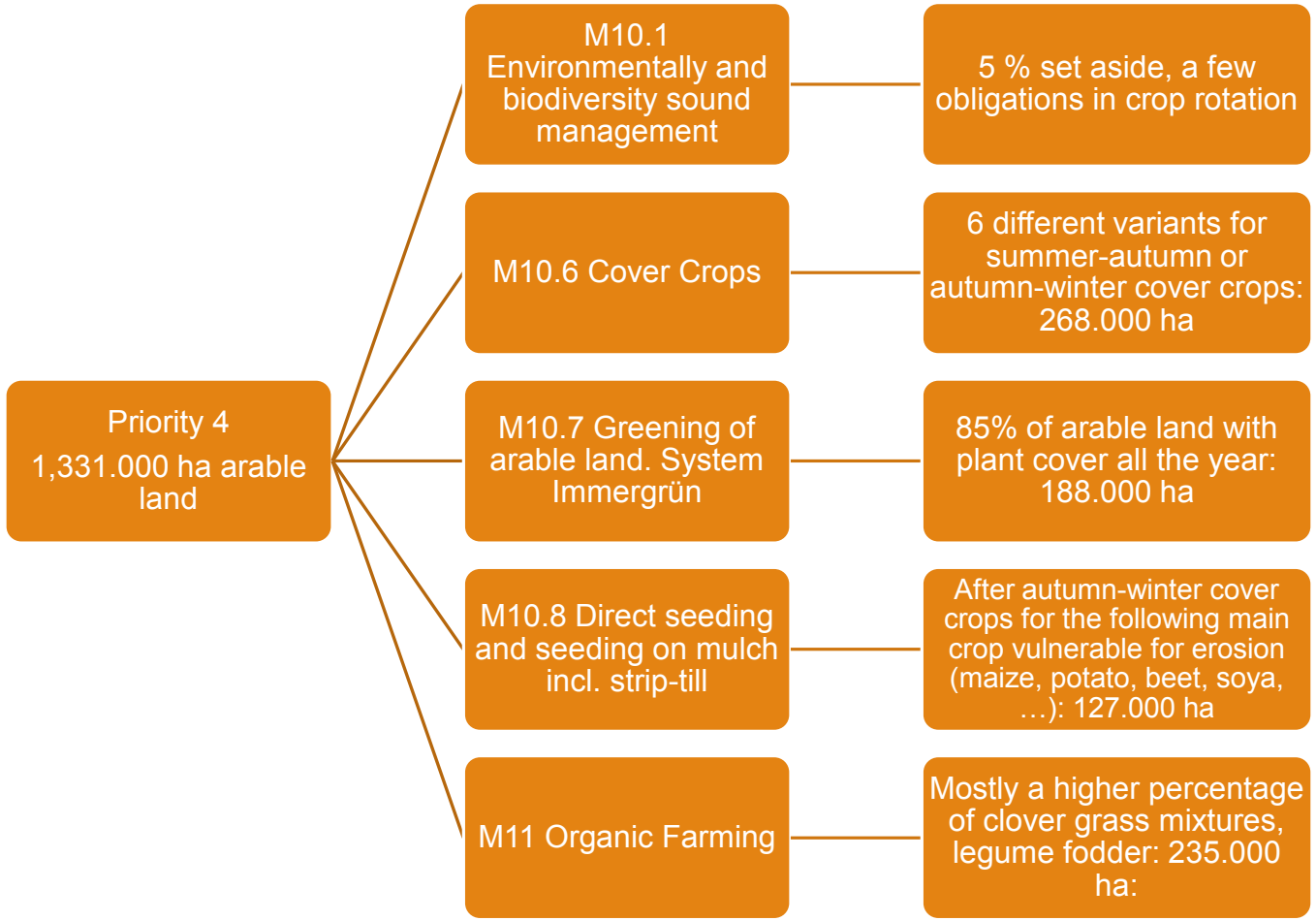
RDP Priority 4 on Arable Land Overview - Austria



Priority 4

Restoring, preserving and enhancing ecosystems related to agriculture and forestry

Focus Area 4C

Sustainable management of natural resources and climate: Reduction of soil erosion and improvement of soil management

Common Impact Indicators

I.12 Soil Organic Matter on arable Land

I.13 Soil Erosion

Evaluation Approach: Changes in SOC

- Soil mapping of all agricultural area land was conducted decades before the RDP, basically these data were used for the FAO-SOC-map
- Soil inventories esp. on Heavy Metal contents including SOC were performed on a regular grid of a 3-5 km (about 25 more points compared to LUCAS)
- Long term field experiments on different management measures were performed at different sites (manure & fertilizer, tillage systems)
- Data was used in the Austrian GHG inventory for the establishment of management factors and for calculating the changes of SOC stocks acc. IPCC Guideline (LULUCF)
- SOC (and other parameters) from soil testing for the farmers were evaluated statistically on regional level and land use esp. on arable land over time, but sufficient data are only available for few regions
- At the present RDP, in a few selected regions for preventive groundwater protection SOC analysis is obligatory for the first time ever in the Austrian RDP at a high frequency: per 5 ha one soil sample

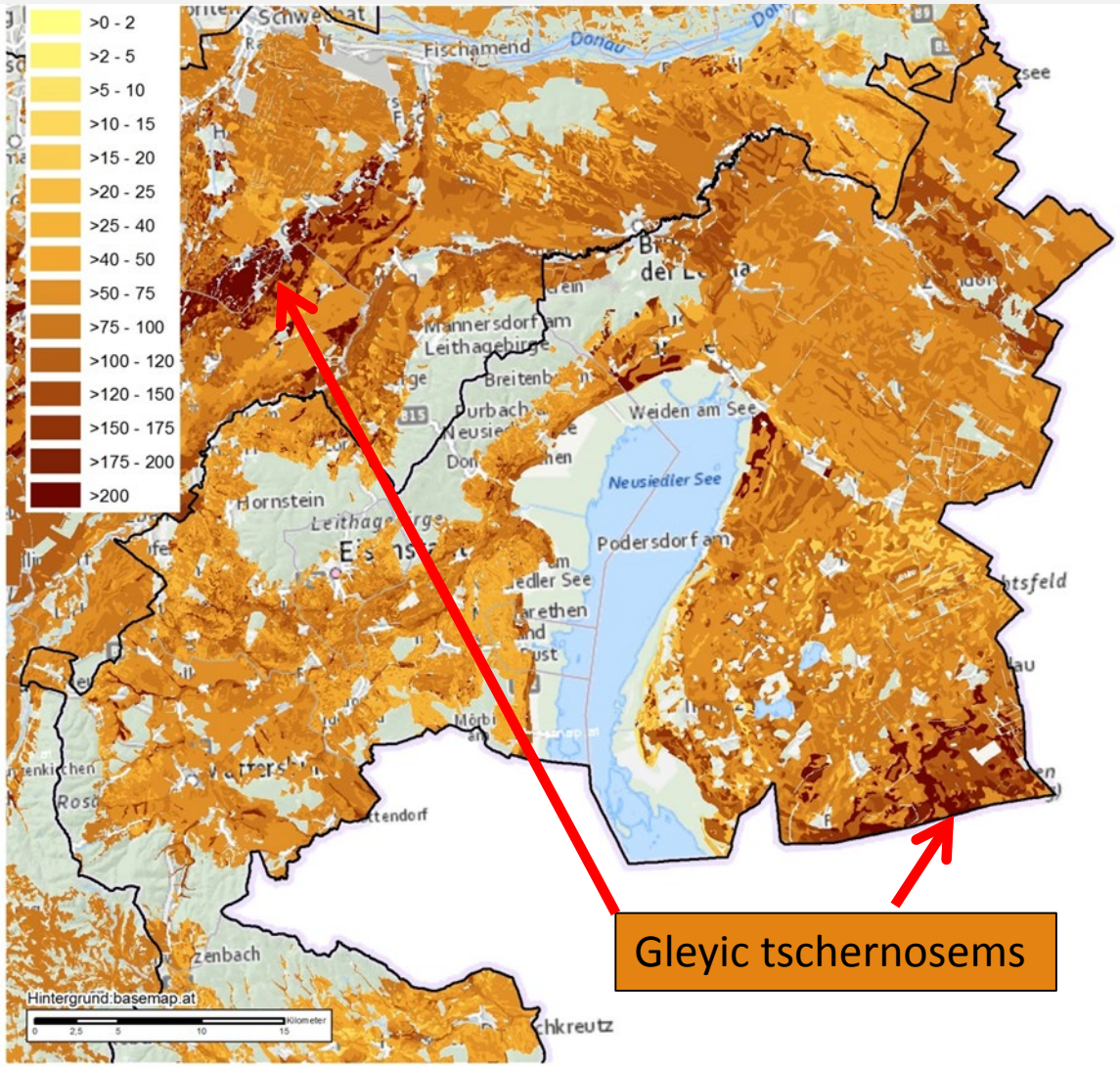
Evaluation Elements

Table 1: Evaluation elements used

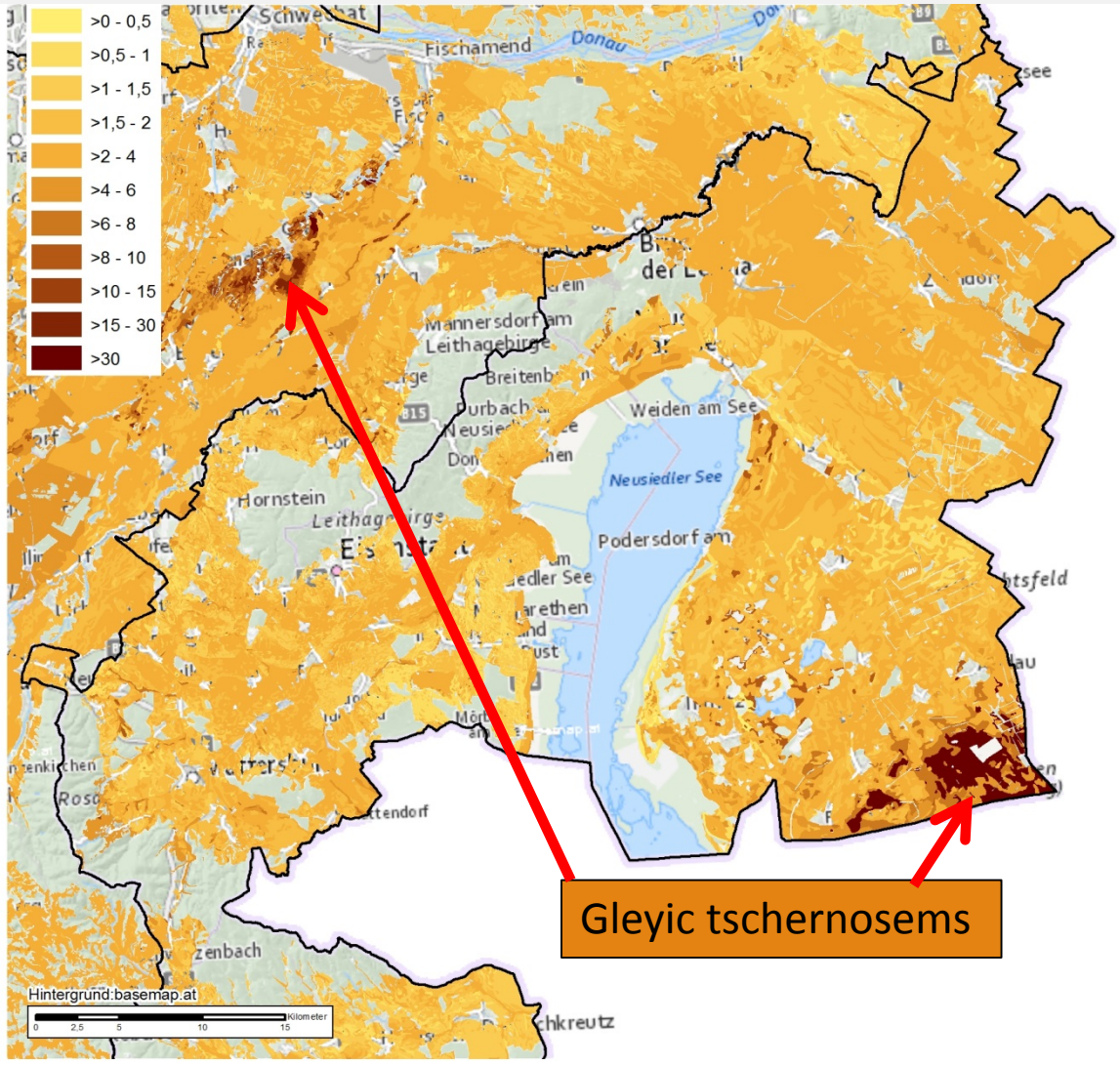
Evaluation questions	Indicators
Common Evaluation Question N. 28: To what extent has the RDP contributed to the CAP objective of ensuring sustainable management of natural resources and climate action?	**Common:** I.12 SOC on Arable Land I. 13 Soil Erosion esp. on Arable Land **Additional:** Determination of Active Carbon is proposed instead of SOM bio (see Technical Annex), procedure on regular prepared and dried soil samples at moderate costs

Austrian Soil Organic Carbon Map (part of FAO GSOC-project): Eastern part of Austria near Bratislava (in the south of Danube)

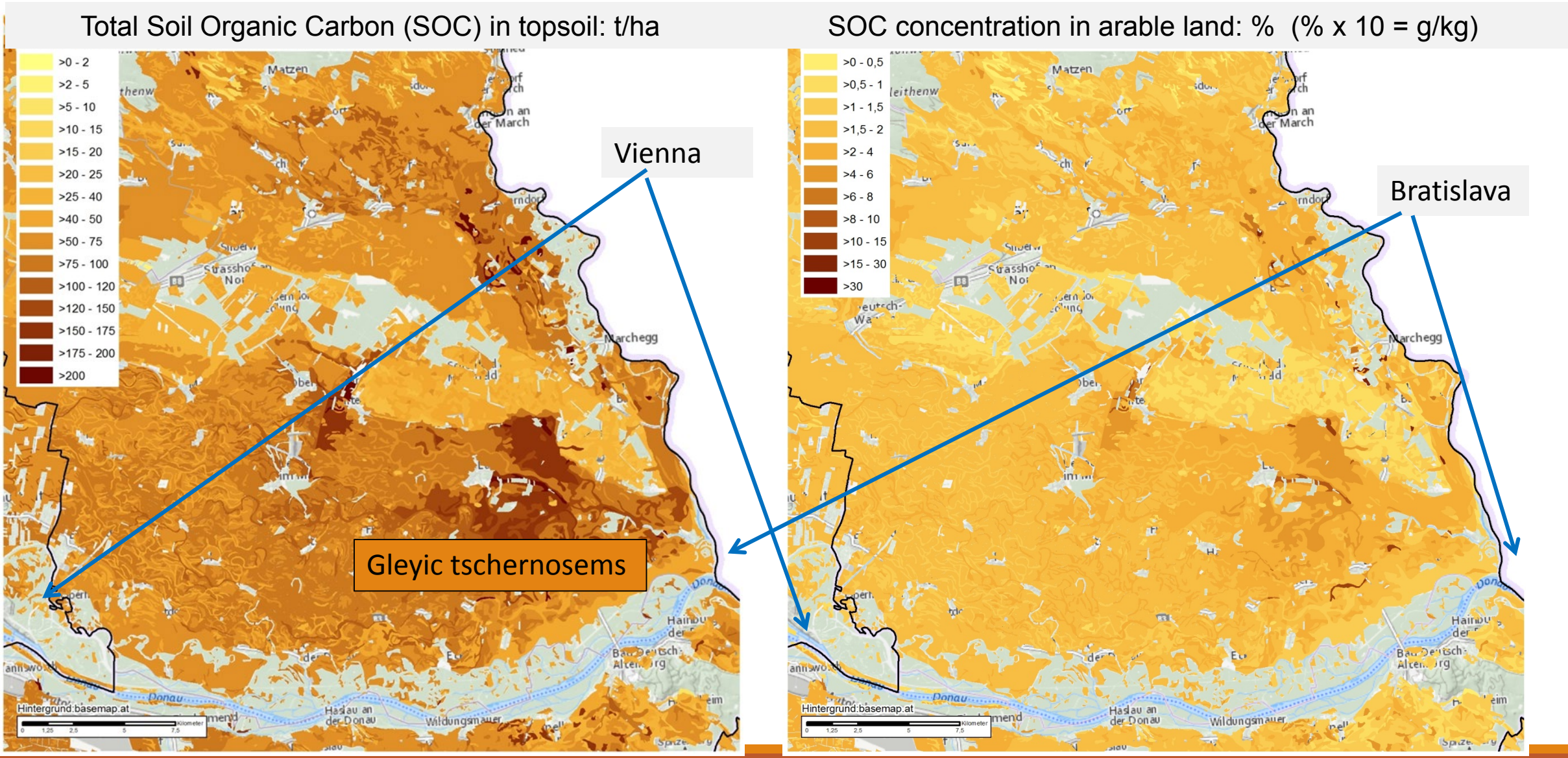
Total Soil Organic Carbon (SOC) in topsoil: t/ha



SOC concentration in arable land: % (% x 10 = g/kg)



Austrian Soil Organic Carbon Map (part of FAO GSOC-project): Eastern part of Austria near Bratislava (in the north of Danube)



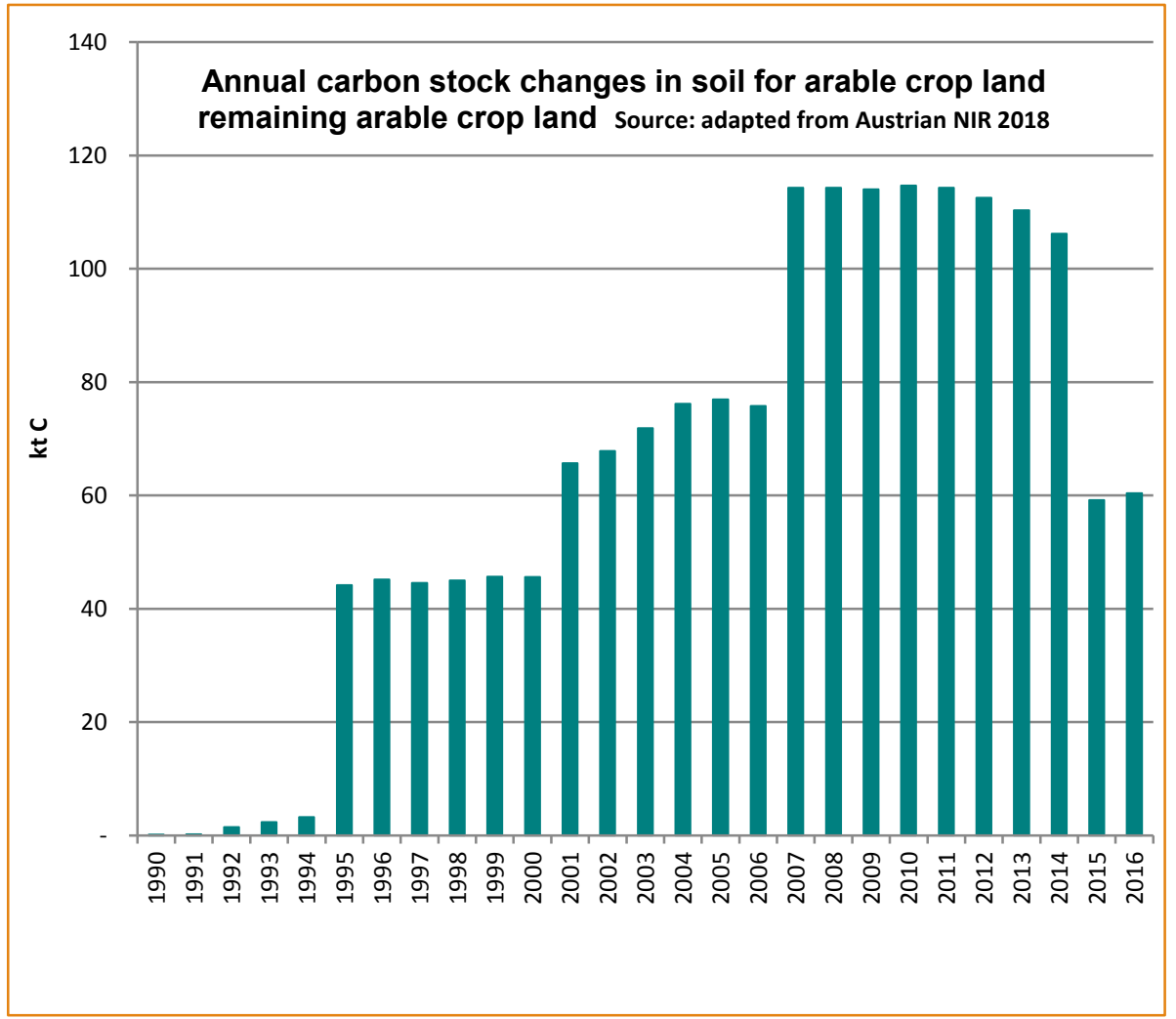
Annual carbon stock changes acc. to different RDP measures starting in 1995

Source: **AUSTRIA'S NATIONAL INVENTORY REPORT 2018** Submission under the United Nations Framework Convention on Climate Change and under the Kyoto Protocol

Emissions/removals due to soil C stock changes in „annual cropland remaining annual cropland" were calculated using a country specific methodology (Tier 2). For the soil organic carbon content the Austrian specific average value of 50 t C ha-1 for 0–30 cm depth of cropland was assumed for 1990 which is based on the results of the Austrian soil inventory, which were carried out between 1988 and 1996, BL et al. 2003). The further methodology follows closely the 2006 IPCC GL, where the IPCC equation 2.25 includes a management factor (FMG), a land-use factor (FLU) and an input factor for input of organic matter (FI) (Table 5.5, IPCC 2006).

In a study by the Austrian Agency for Health and Food Safety (AGES) and Umweltbundesamt (UMWELTBUNDESAMT 2010b) the IPCC default management factors for SOC (soil organic carbon) stock change have been assessed against results from national long-term field experiments of AGES. The country-specific land-use factor (FLU) for long-term cultivated cropland soils of 0.93 is applied according to the results of the long-term field experiments of AGES (UMWELTBUNDESAMT 2010b).

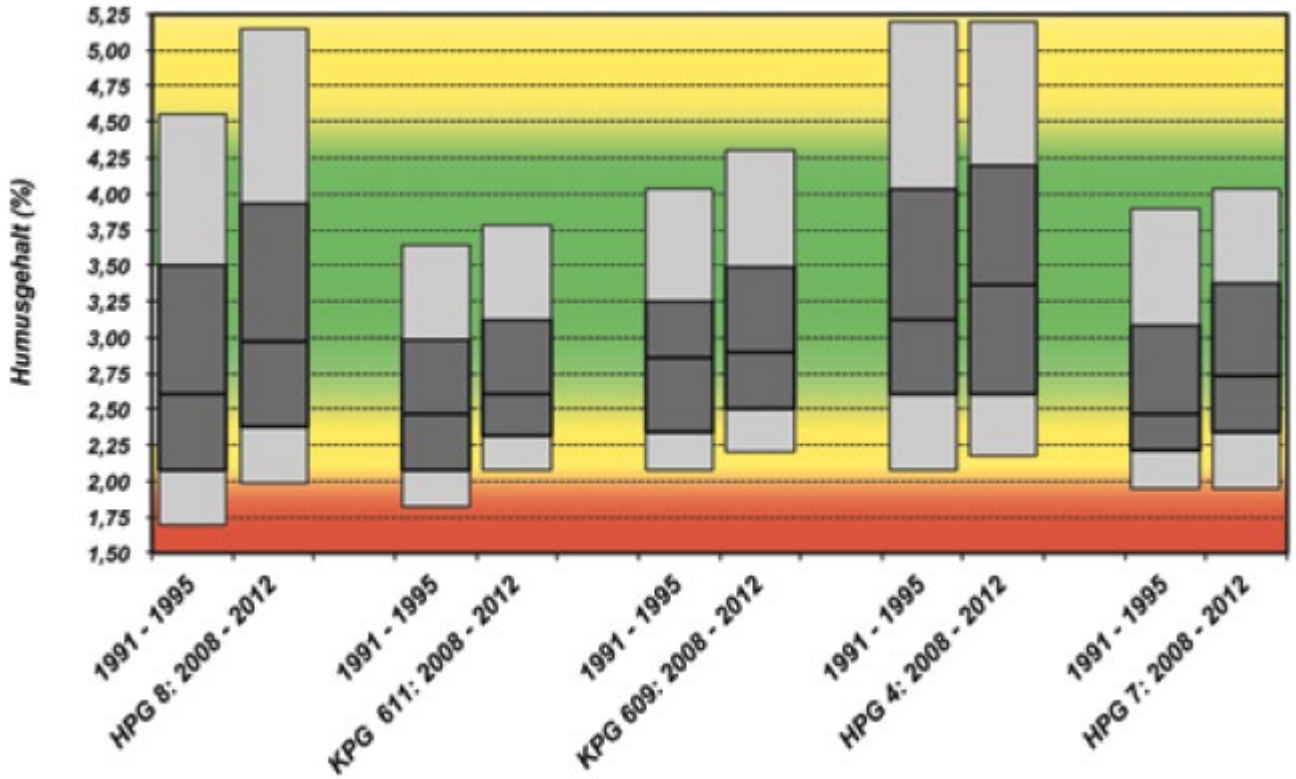
The stock change factors for management (FMG) were also applied according to the results of the long-term field experiments of AGES (UMWELTBUNDESAMT 2010b, SPIEGEL et al. 2007), showing the effects of different tillage types (minimum, reduced and conventional tillage) on soil organic carbon. According to these results, FMG-full and FMG-reduced have the same country specific management factor of 1.0. For FMG-no-till the country specific management factor of 1.09 was derived.



Evaluation of SOC from the soil samples of the farmers at regional level

Region	1991 - 1995	2008 - 2012
Nordöstl. Flach- und Hügelland (HPG 8)	14.621	4.521
St. Pölten-Wieselburg (KPG 611)	2.084	434
OÖ Zentralraum (KPG 609)	74	3.430
Wald- und Mühlviertel (HPG 4)	2.629	6.798
Südöstl. Flach- und Hügelland (HPG 7)	296	2.868

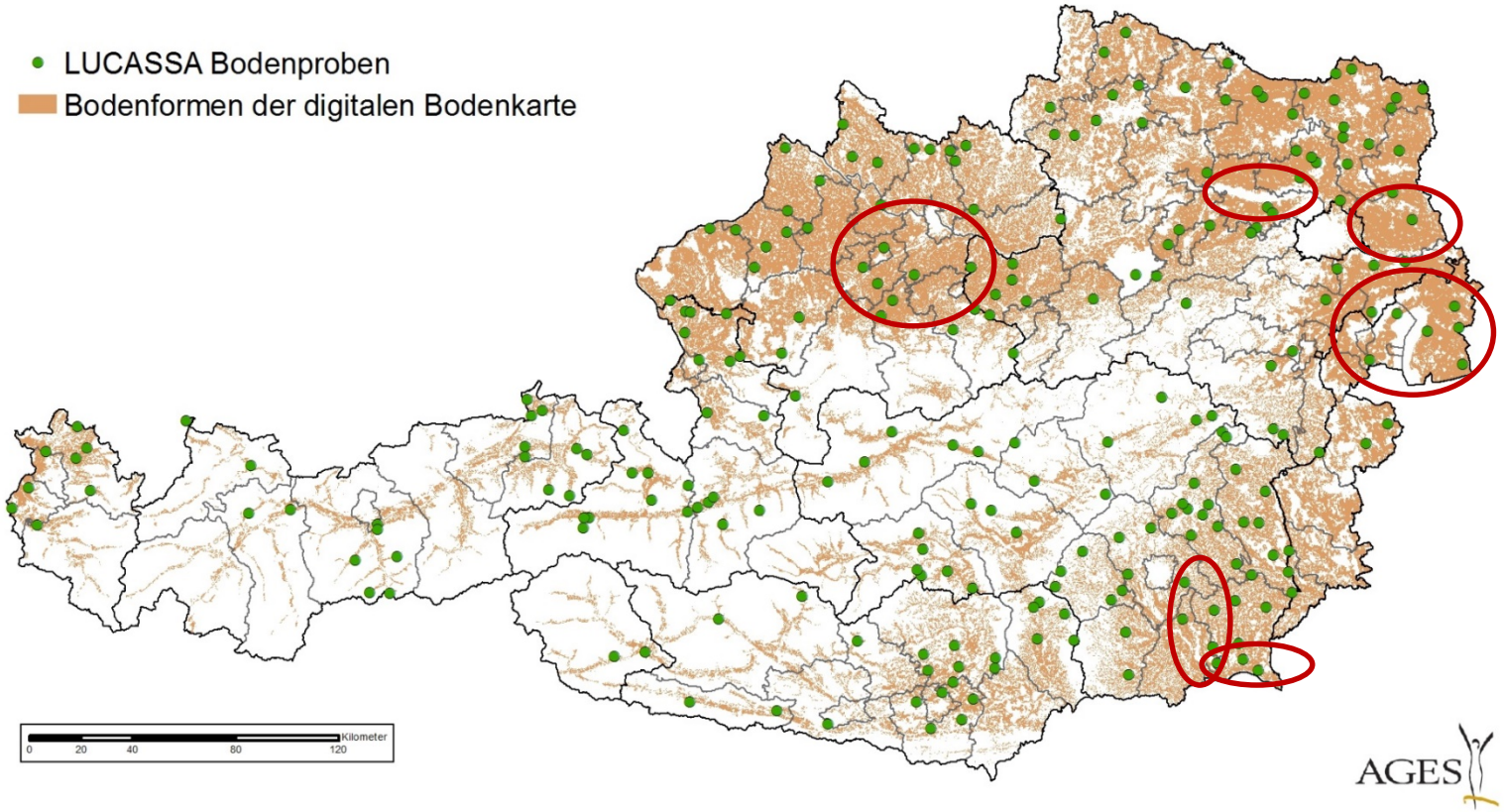
Promoting of soil monitoring programmes in cooperation with the stakeholders and farmers will be done, partly financed by EU-Technical Support especially in regions with missing data



Sites of soil sampling of LUCAS in Austria

The actual RDP for Groundwater Protection Areas, where soil testing including SOC is obliged for every 5 ha arable land: Marchfeld 30.000 ha conv. vs. 7.000 ha organic farming offers the evaluation of comparison groups at regional level for SOC.

In the long term, when LUCAS soil sampling is repeated at the identical points, these data may be used for evaluation of the long term change of SOC, but only the top soil is analysed, and the soil management (RDP measures) should be recorded precisely over the years.



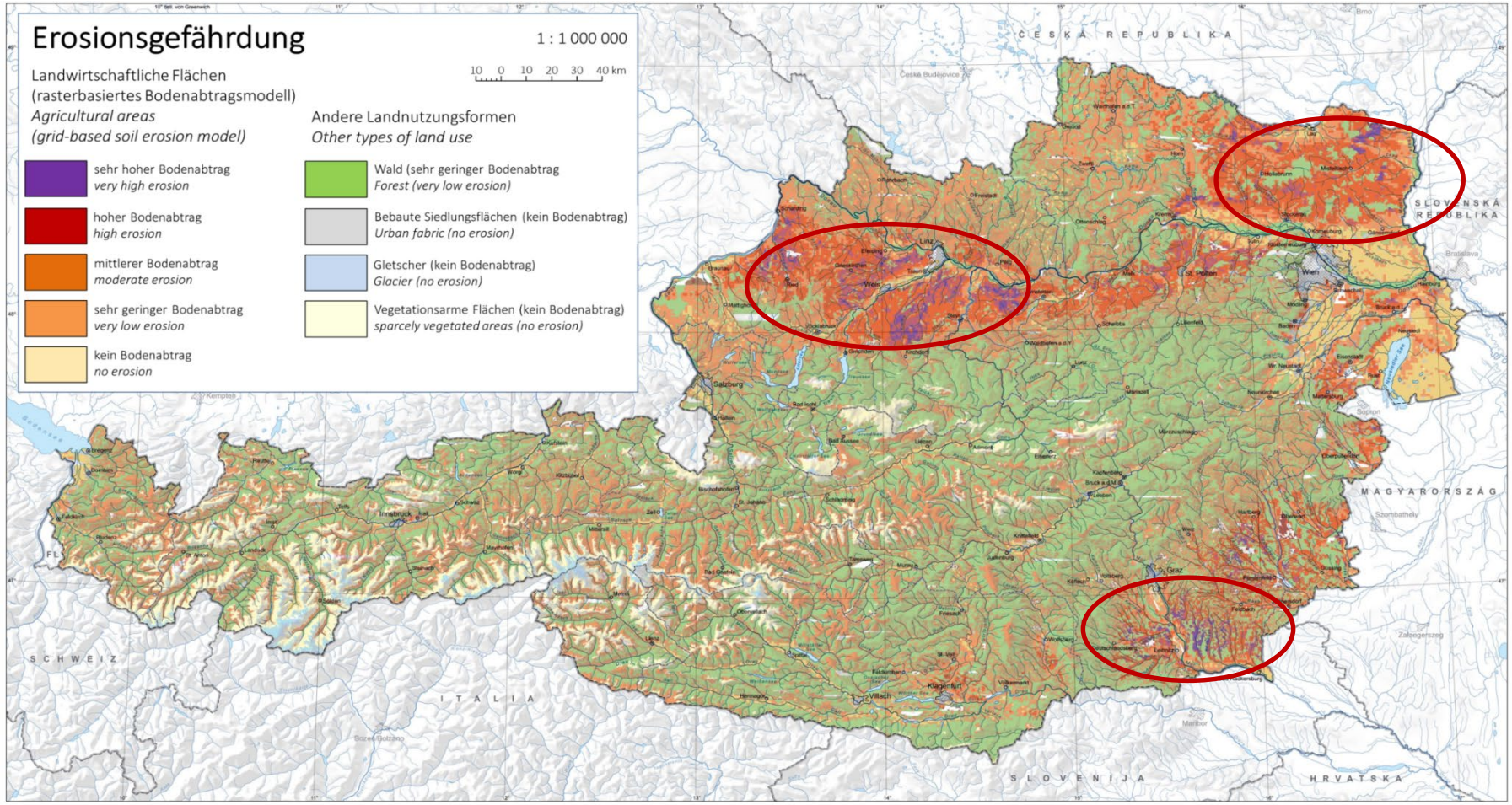
I.13 Soil Erosion (1)

- **Estimations by USLE**: RDP measures “cover crops” and following “mulch seeding” reduce soil erosion in the former RDP – period 2007-2013.

- **The Revised Universal Soil Loss Equation (RUSLE) will be used for the Evaluation 2019:** The effects of “cover crops”, Mulch seeding and different crop rotation in conventional and organic farming are calculated

I.13 Soil Erosion (2)

- The RUSLE-model for all arable land incl. vineyards and orchards will be used for evaluation 2019
- All RUSLE components will be calculated (soil erodibility, cover-management factor, support practice and rain factor)
- The model calculation will be done with and without the support practice factor cover crops and reduced tillage or direct seeding (RDP measures) and conv. and organic farming



Key findings

What is the effect of the increase of SOC on soil quality and erosion?

- A 1% mass increase in SOC (+10 g SOC/kg) on average increased available water capacity between 1,4 and 1,9 mm per 100 mm soil layer (Minasny & Mcbratney 2018: Based on data from 60 publications and global databases with more than 50.000 measurements).

- For the I. 12 related to the top soil 20 cm layer this conclusion means an increase of 2,8 to 3,8 mm. Sandy soils were more responsive, the effect on clayey soils were almost negligible. The most effect was in large pores, possibly from the formation of macroaggregates.

- Therefore from the Austrian results scenario the increase of SOC by 2-3 g /kg over last 20 years has small effects on soil water storage capacity. The SOC-stock increase of about 1,2 t per ha and 20 years (SOC-change up to + 85 kg SOC/ha per year, currently about + 45 kg SOC/ha per year) is presented in the Austrian National Inventory Report 2018. In a few years a new Equilibrium state might be reached.

Strengths and Weaknesses

Table 2: Strengths and weaknesses of methodology

Strengths	Weaknesses
• The implementation of RUSLE is a milestone in erosion evaluation • For the first time in Austrian RDP the analysis of SOC was obligatory, the sampling density is sufficient in a few representative regions • Comparisons between different RDP measures can be carried out, esp. organic and conventional farming	• Comparisons between beneficiary and non-beneficiary farms are difficult, nonparticipants of the RDP are less interested in soil monitoring programmes • The continuity and consistency of soil sampling in RDP is lacking, the evaluation of SOC is hampered • Quantity of mulch and quality of mulch seeding is different at farm scale, by the advisory service improvements are evident.

Lesson learnt and applicability

- All available sources of data should be included, esp. reports from other public authorities (National Inventory Report), scientific papers, soil taxation, soil survey
- Mis-judgement of outliers in soil samples (extremely high or low SOC results) without comprehensive knowledge (Gleyic tschernosems)
- SOC: The results of model calculation and soil samples from farmers are in agreement
- At regional level, sound soil monitoring programmes are at the beginning, but long term funding is not secured
- In the long term, LUCAS sites will be suitable in the evaluation, when the agricultural management is documented exactly (with samples from 20 – 60 cm)

Lessons learnt and applicability

- Nonetheless a sound SOC management should still be maintained, esp. for improving soil structure and nutrient cycling.

- The macro-pores created by organic matter have important effects in increasing infiltration and aeration and prevention of soil compaction.

- The accelerated soil erosion in EU agricultural land due to more intense precipitation of an just published erosion model (a 35% increase in eroded carbon in the period 2016-2100) should be prevented.

Photo: Soil compaction in the traffic lanes

Further literature

- Minasny B. & A.B. Mcbratney: Limited effect of organic matter on soil available water capacity. European Journal of Soil Science, January 2018, **69**, 39-47. https://onlinelibrary.wiley.com/doi/full/10.1111/ejss.12509

- AUSTRIA'S NATIONAL INVENTORY REPORT 2018, Submission under the United Nations Framework Convention on Climate Change and under the Kyoto Protocol. http://www.umweltbundesamt.at/emiberichte

- Tatzber M. et al.: KMnO4 determination of active carbon for laboratory routines: three long-term field experiments in Austria. *Soil Research*, 2015, **53**, 190–204. http://dx.doi.org/10.1071/SR14200

- Spiegel H. et al. (2007): Tillage effects on soil organic carbon and nutrient availability in a long-term field experiment in Austria. Die Bodenkultur 58 (1-4). https://www.boku.ac.at/en/fos/themen/die-bodenkultur/inhalte/band-58-2007/band-58-heft-1-4/spiegel/

Thank You

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