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Mapping the spatial patterns of field traffic by means of GPS-data received from farm vehicles

Mapping the spatial patterns of field traffic by means of GPS-data received from farm vehicles

Rainer Duttmann [1,2] & Michael Nolde [2]

University of Kiel

[1] Department of Physical Geography
- Landscape Ecology and Geoinformation Science -

[2] Center for Geoinformation Processing

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Quellen: http://themenpark_umwelt.baden-wuerttemberg.de (Foto links oben)
www.shz.de/typo3temp/pics/ade394a24d.jpg (Foto links unten)
www.umweltbundesamt.de/landwirtschaft/index.htm (Foto rechts)

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Outline

1. Einleitung – Warum dieses Thema?
2. Daten und Methoden
3. Biomasselogistik auf Straße und Feld – Anwendungen von "user generated data" an Beispielen aus der Landwirtschaft
4. Modellierung von Befahrungsintensitäten und kartographische Abbildung von Bodenverdichtungsrisiken in Ackerschlägen
5. 3D-Visualisierung von Unterbodenbelastungen – „Tomographie" des Bodens
6. Zusammenfassung - Ausblick

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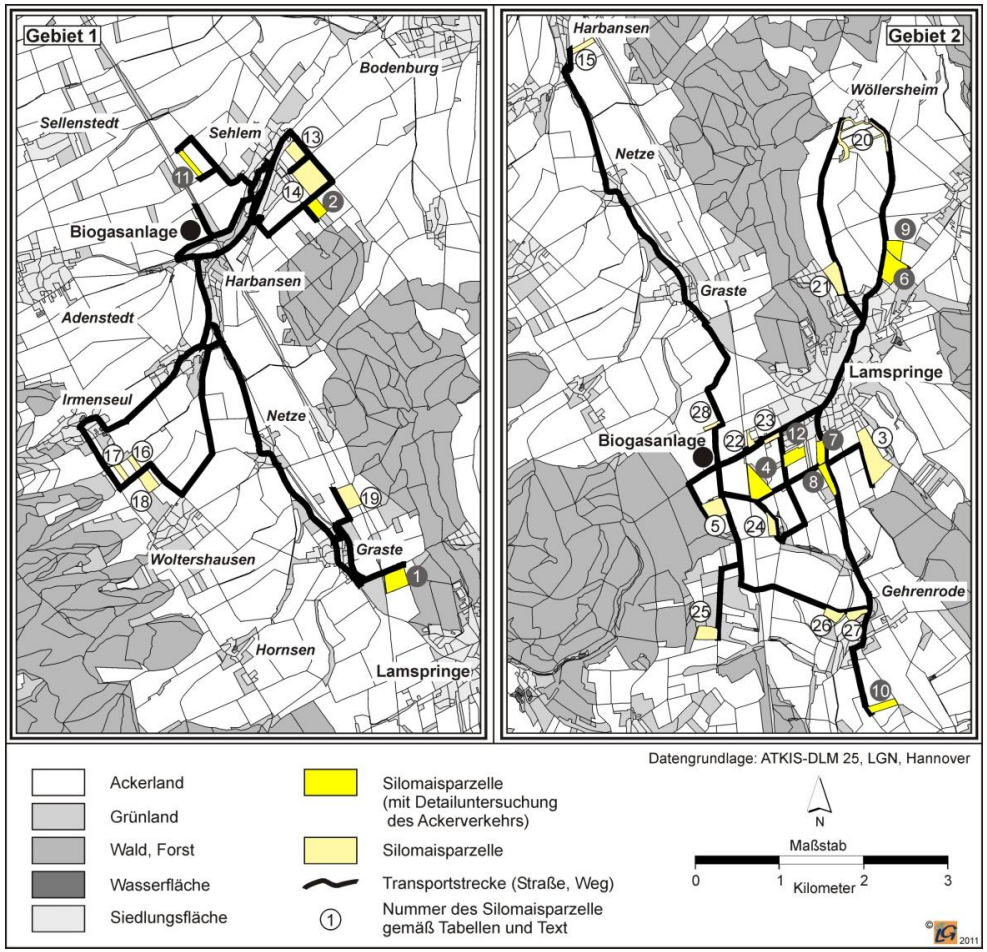
Biomass logistics in the catchment area of biogas installations



Duttmann, R. et al., (2012), KTBL-Schriften, in press

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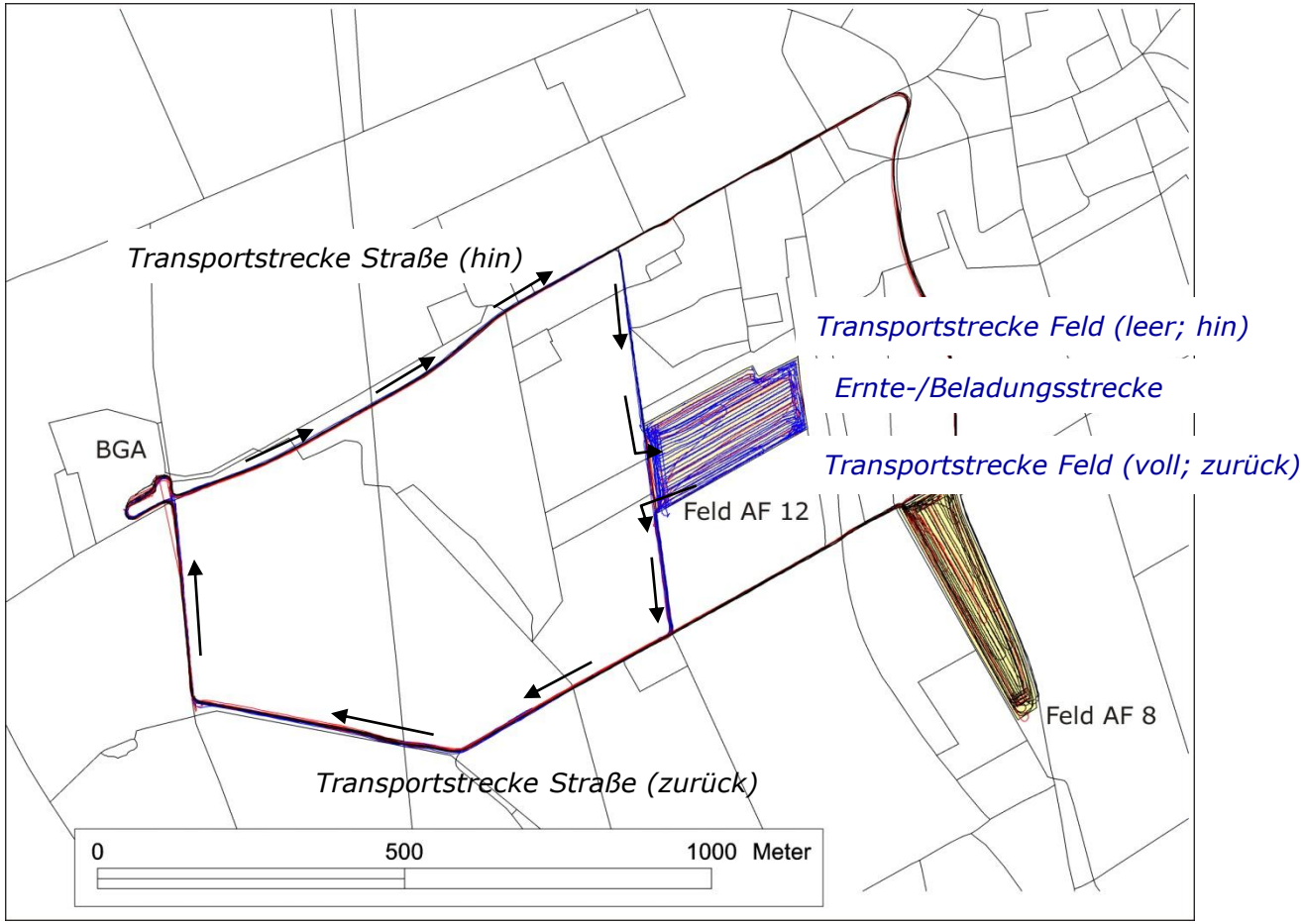
Assessment of agricultural on-road and within-field traffic



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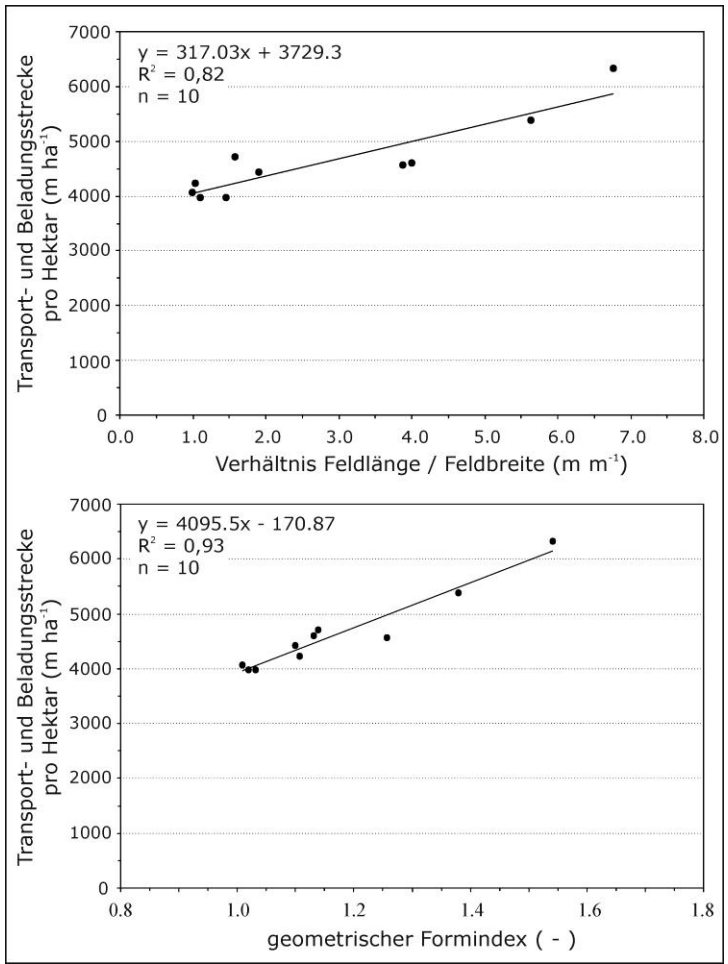
Relationships between wihin-field transportation distance and field geometrie (field shape properties derived from ATKIS DLM-data)



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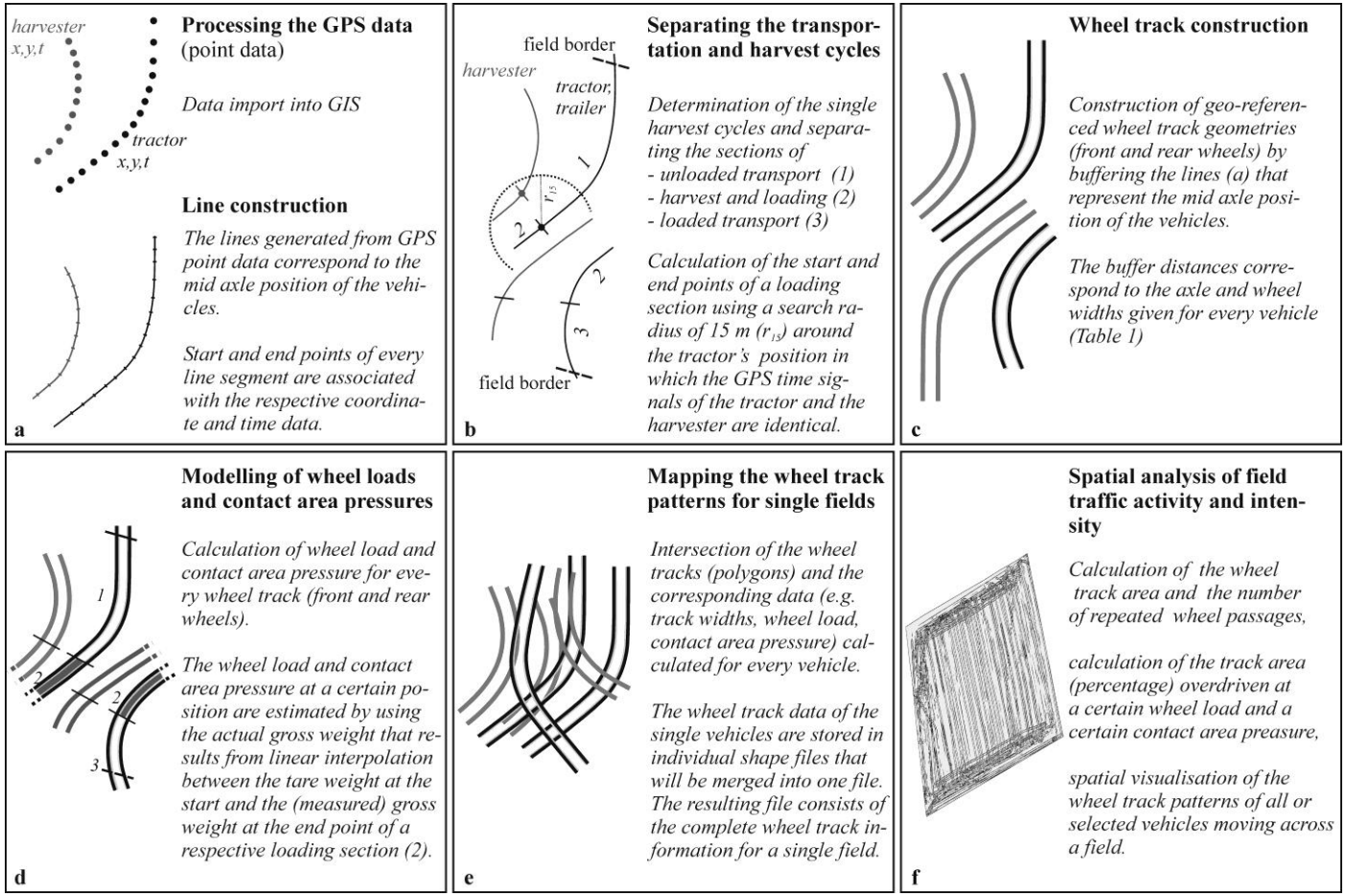
Modeling of field traffic considering the vehicles` characteristics



Duttmann, R. et al., Soil & Till. Res. (2012), in press

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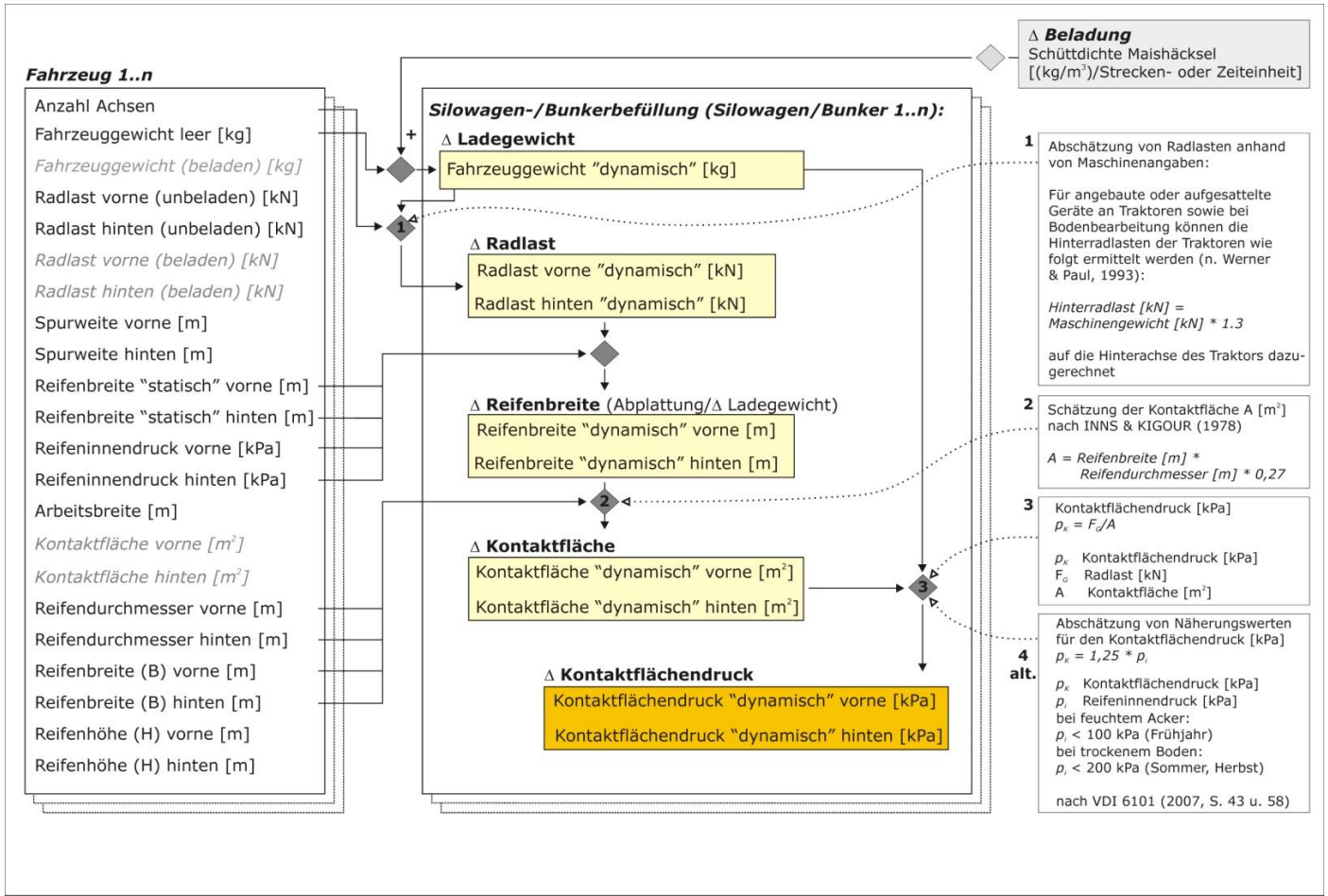
Modeling of axle loads, wheel loads and ground contact pressures and their changes during loading – Mapping the spatio-temporal changes of stresses



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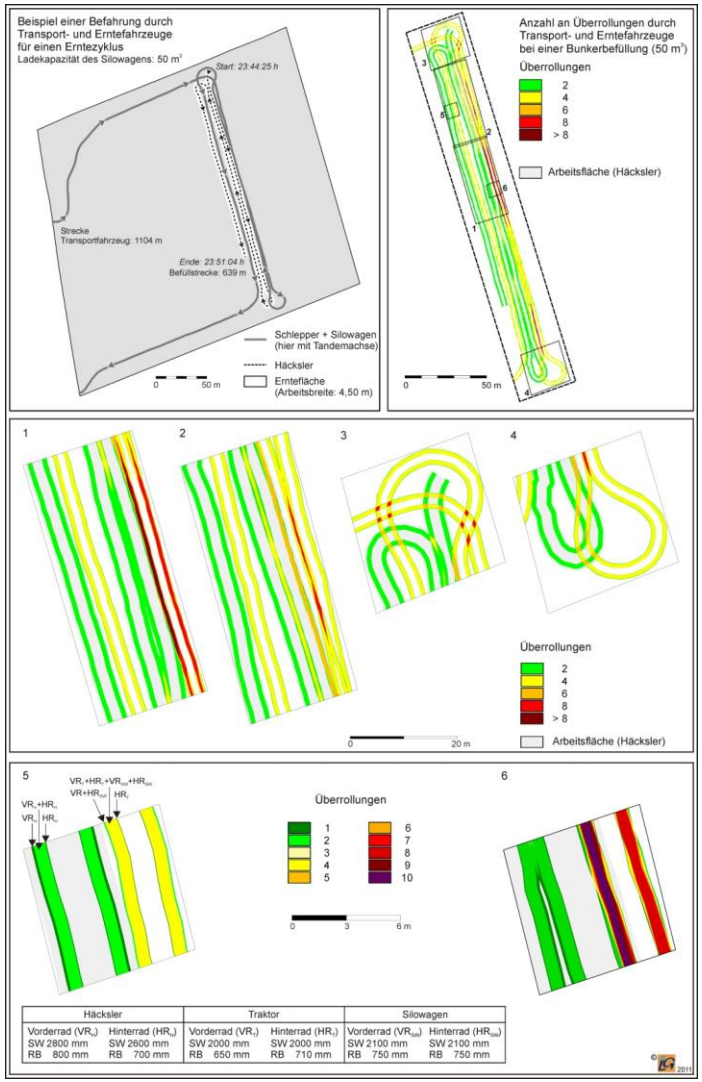
Representation of georeferenced wheel tracks for individual vehicles and mapped patterns of rolling-over frequency



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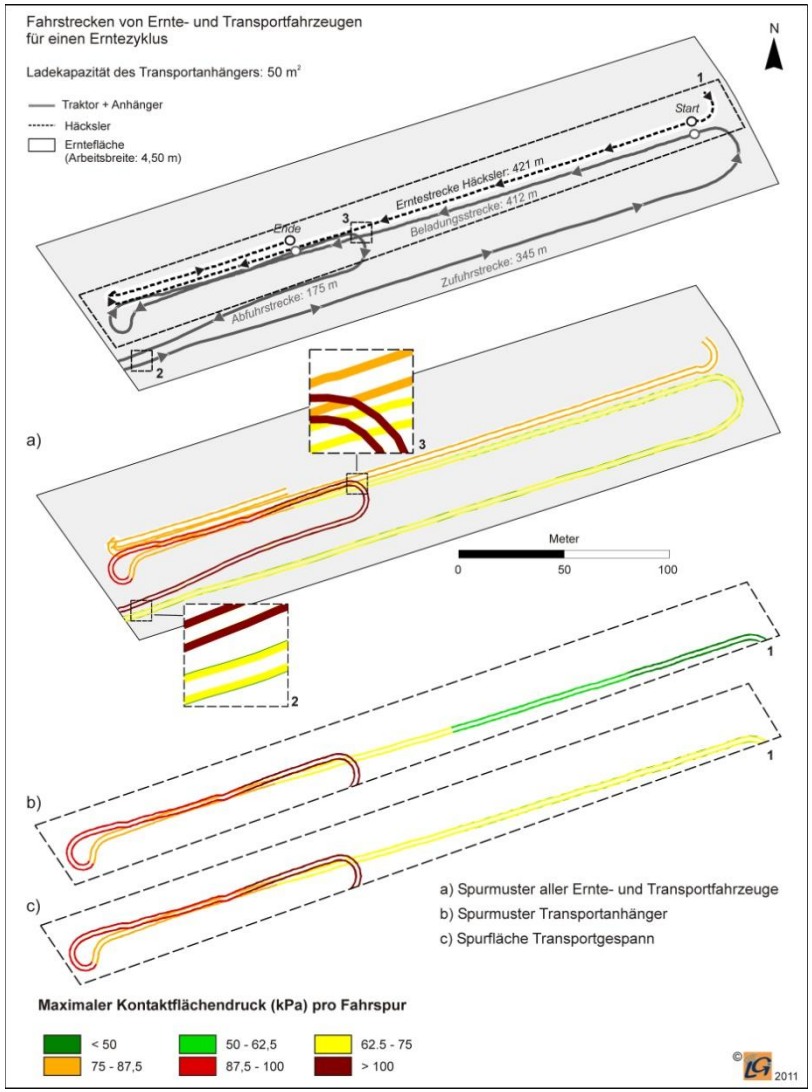
Changes of ground contact pressures along the harvest section at the example of a single transportation and harvesting cycle



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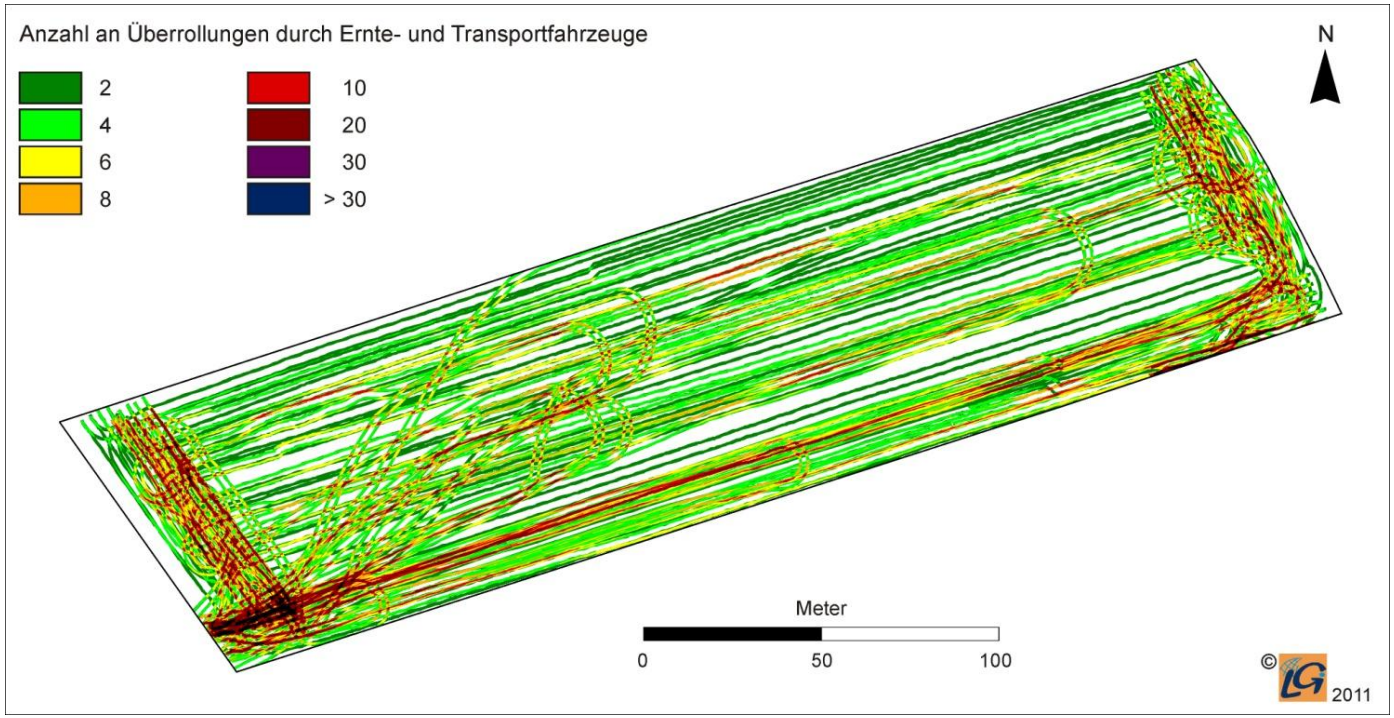
Rolling-over frequency during silage maize harvest on a single field (representing all vehicle tracks)



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Number of rolling-overs of the single farm vehicles and vehicle combinations

Über-rollungen	Spurfläche									
	Traktor		Silowagen		Häcksler		Transportzug		Alle Fahrzeuge	
n	m^2	%[1)]	m^2	% [1)]	m^2	% [1)]	m^2	% [1)]	m^2	% [1)]
≤ 2	7 969	29.1	8 103	29.6	8 408	30.7	1 049	3.8	5 777	21.1
> 2 - ≤ 4	2 183	8.0	2 376	8.7	1 140	4.2	7 242	26.5	5 703	20.8
> 4 - ≤ 6	504	1.8	564	2.1	195	0.7	578	2.1	2 377	8.7
> 6 - ≤ 8	142	0,5	157	0.6	38	0.1	1 905	7.0	1 566	5.7
> 8 - ≤ 10	45	0.2	53	0,2	6	-	172	0.6	809	3.0
> 10 - ≤ 12	13	-	16	< 0,1	< 1	-	420	1.5	413	1.5
> 12 - ≤ 14	3	-	4	-	-	-	54	0.2	236	0.9
> 14 - ≤ 16	< 1	-	< 1	-	-	-	109	0.4	144	0.5
> 16 - ≤ 18					-	-	22	< 0.1	73	0.3
> 18 - ≤ 20	-	-	-	-	-	-	32	0.1	45	0.1
> 20	-	-	-	-	-	-	21	< 0.1	63	0.2
	10860	39.6	11273	41.3	9787	35.7	11604	42.4	17206	62.8

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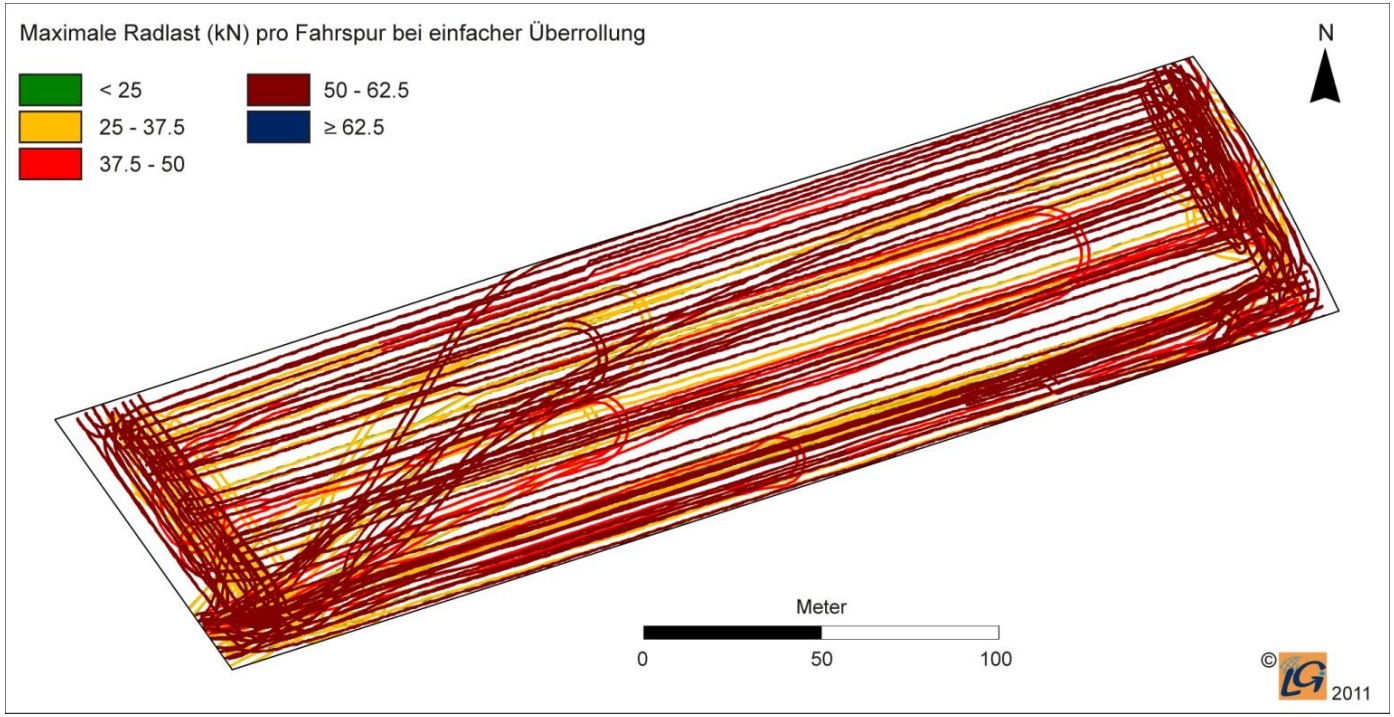
Maximum wheel load (kN) excerted at least once to a wheel track



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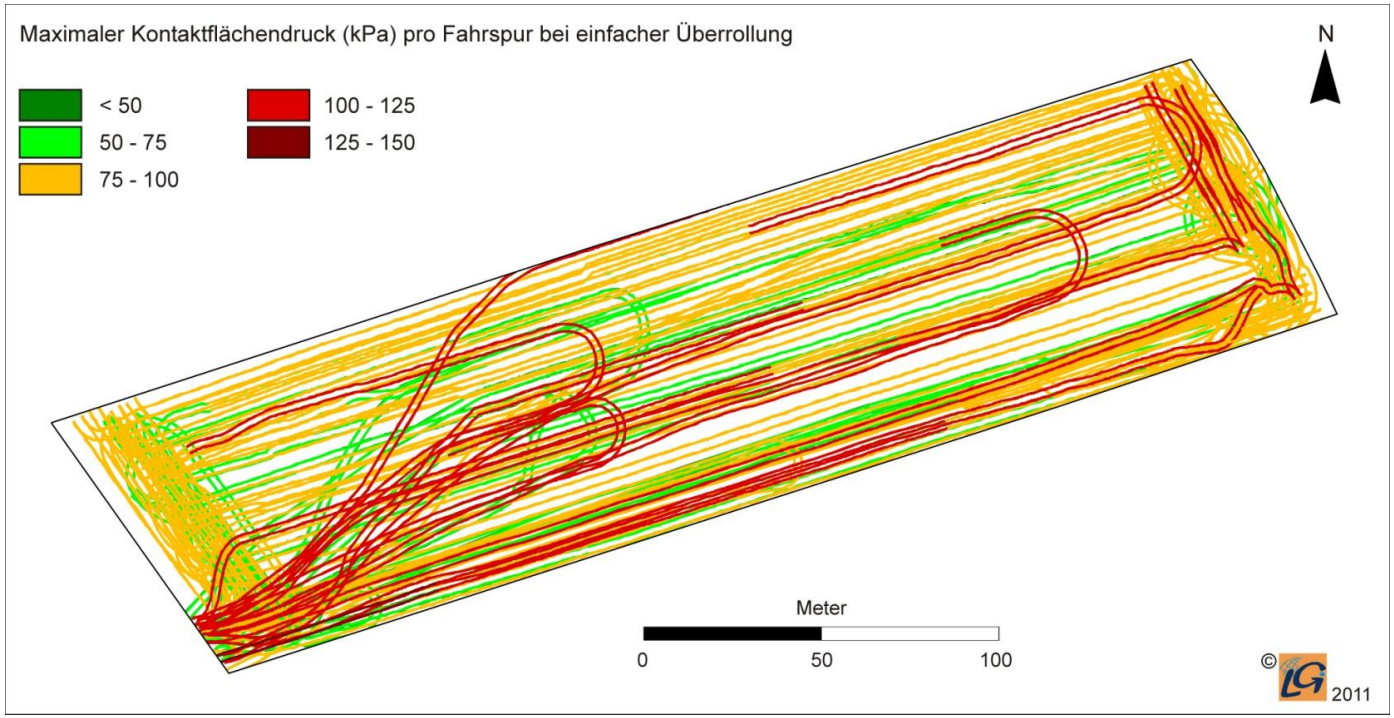
Maximum ground contact pressure (kPa) excerted at least once to a wheel track



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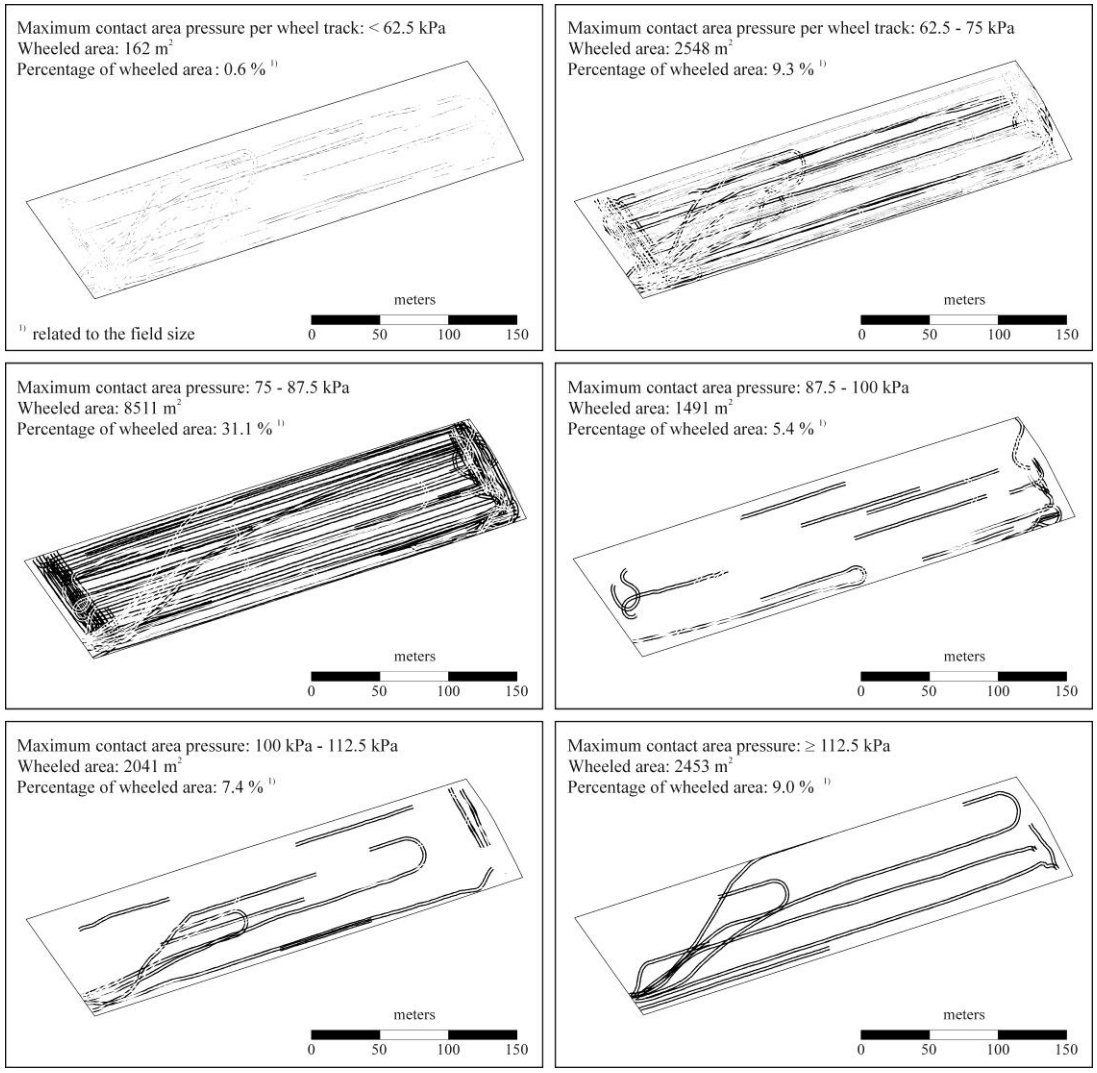
Wheel track patterns differentiated into classes of maximum mean ground contact pressure (ground contact stress)



Duttmann, R. et al., Soil & Till. Res. (2012), in press

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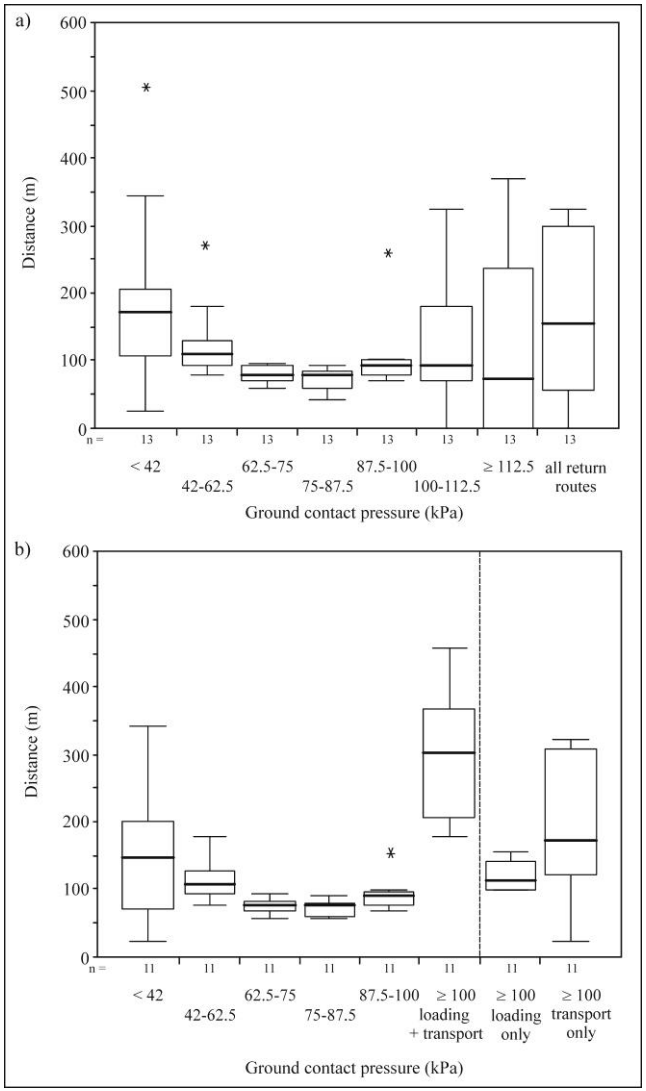
Transportation distances inside a field, related to classes of differing ground contacts pressures (kPa)
- Field No. 10 -



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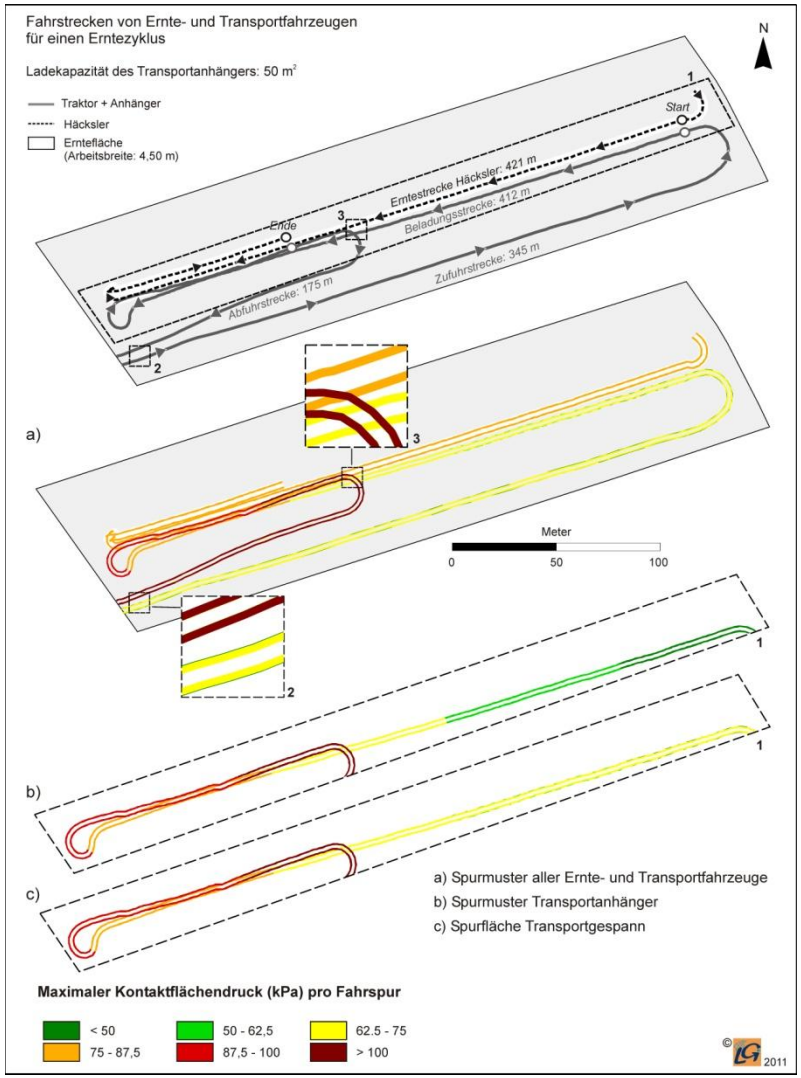
Maximum ground contact pressure at the example of a single transortation and harvesting cycle



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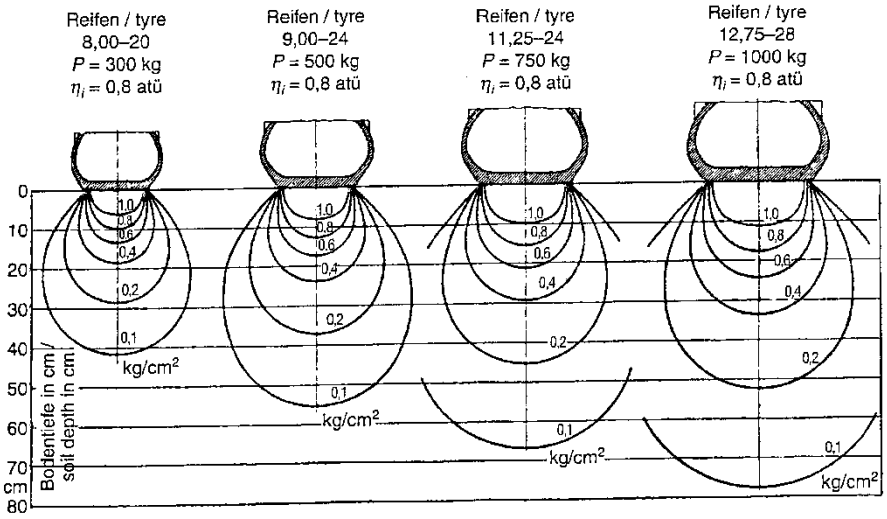
Calculating stress attenuation inside a soil



Quelle: VDI 6101 (2007), S. 45

Konzentrationsfaktor vk (-):

$$vk = \frac{\log\left(\frac{\delta o}{\delta o - \delta z}\right)^2}{\log\left[\left(\frac{r}{z}\right)^2 + 1\right]}$$

δo Druck der Reifenkontaktfläche (kPa)

δz Druck in der Tiefe z (kPa)

r Radius der Reifenkontaktfläche (cm)

z Bodentiefe (cm)

Druckfortpflanzung:

$$\delta z = \delta o \left(1 - \frac{1}{\sqrt{\left[\left(\frac{r}{z}\right)^2 + 1\right]^{vk}}}\right)$$

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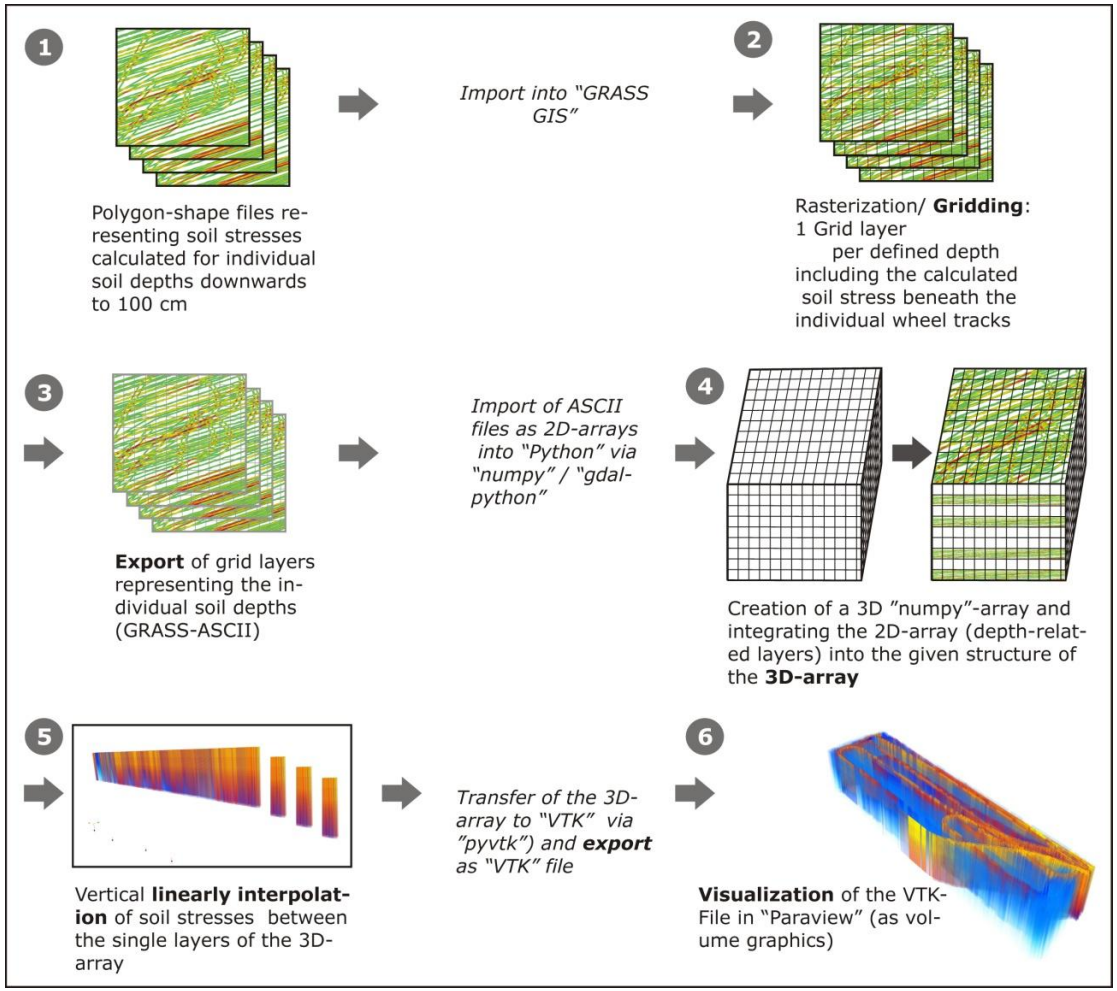
Mapping of hidden processes – „Tomography" at spatial scales



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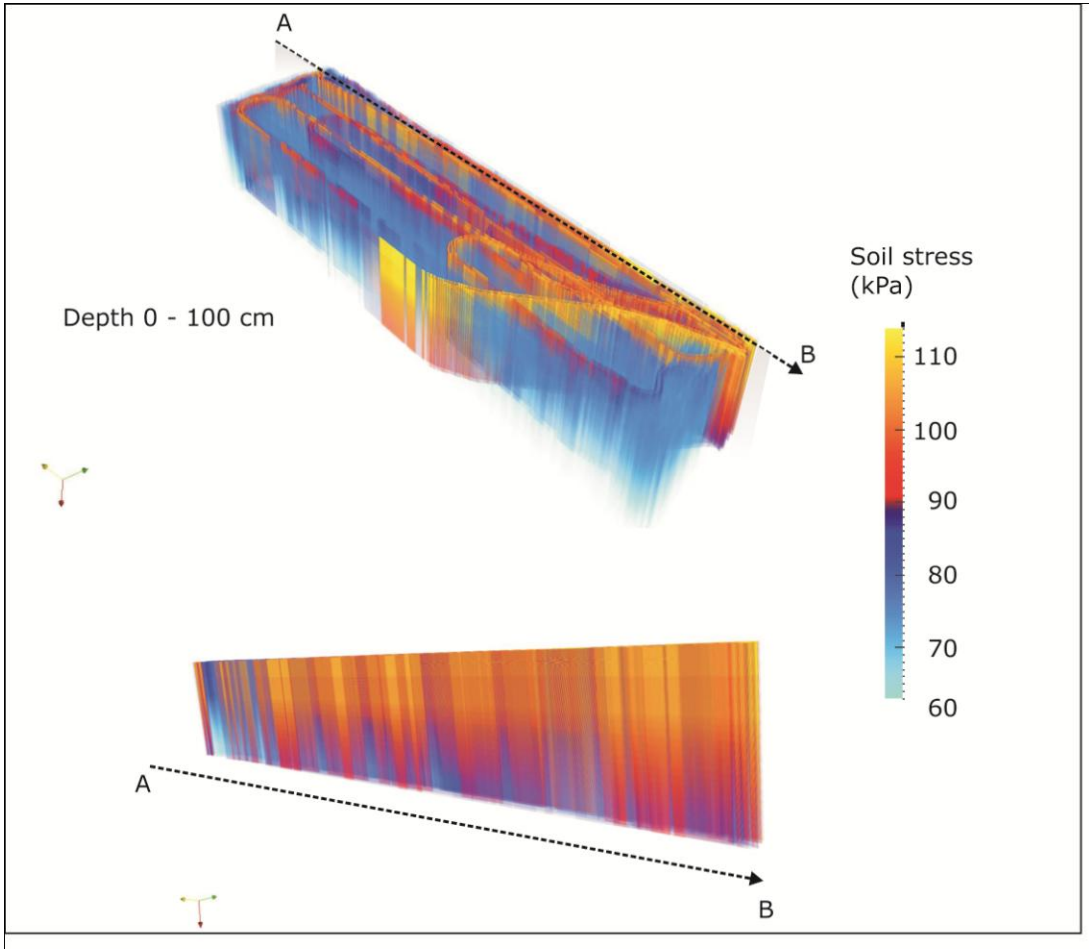
3D-Visualization of stress attenuation beneath a wheel track



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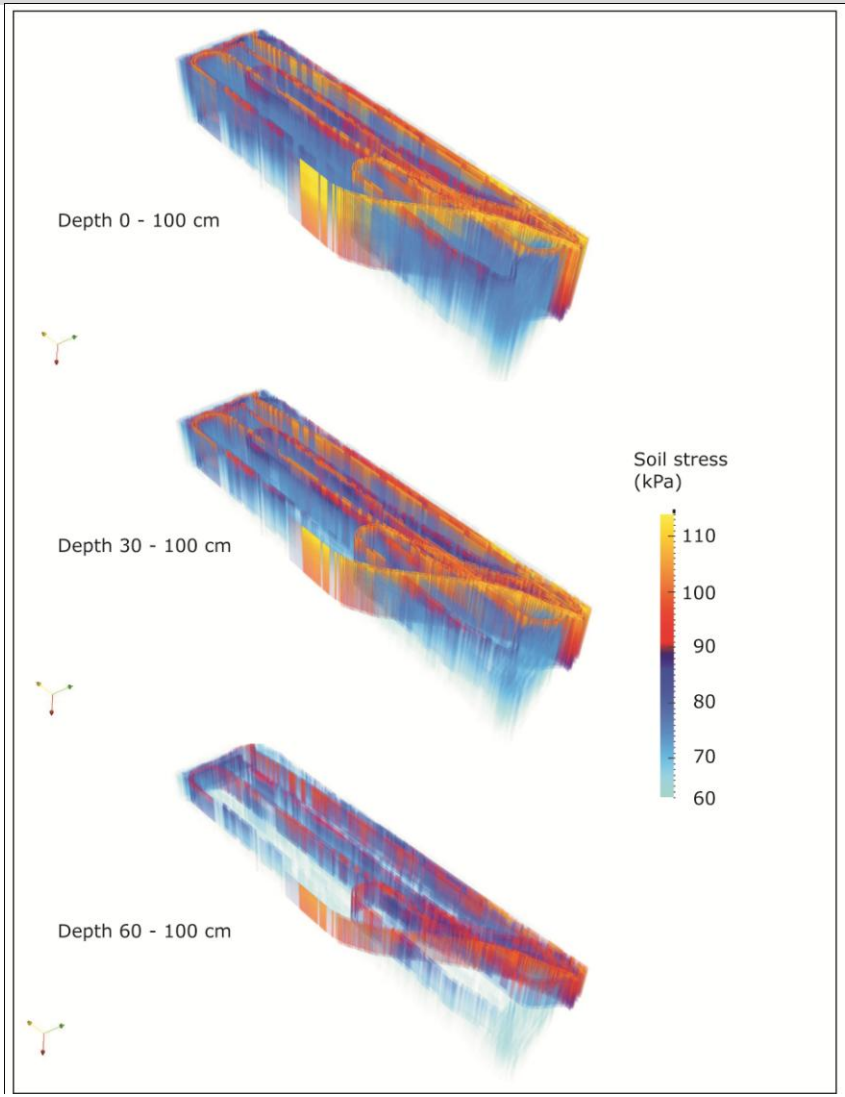
"Tomography" of soil stresses due to field traffic during silage maize harvest



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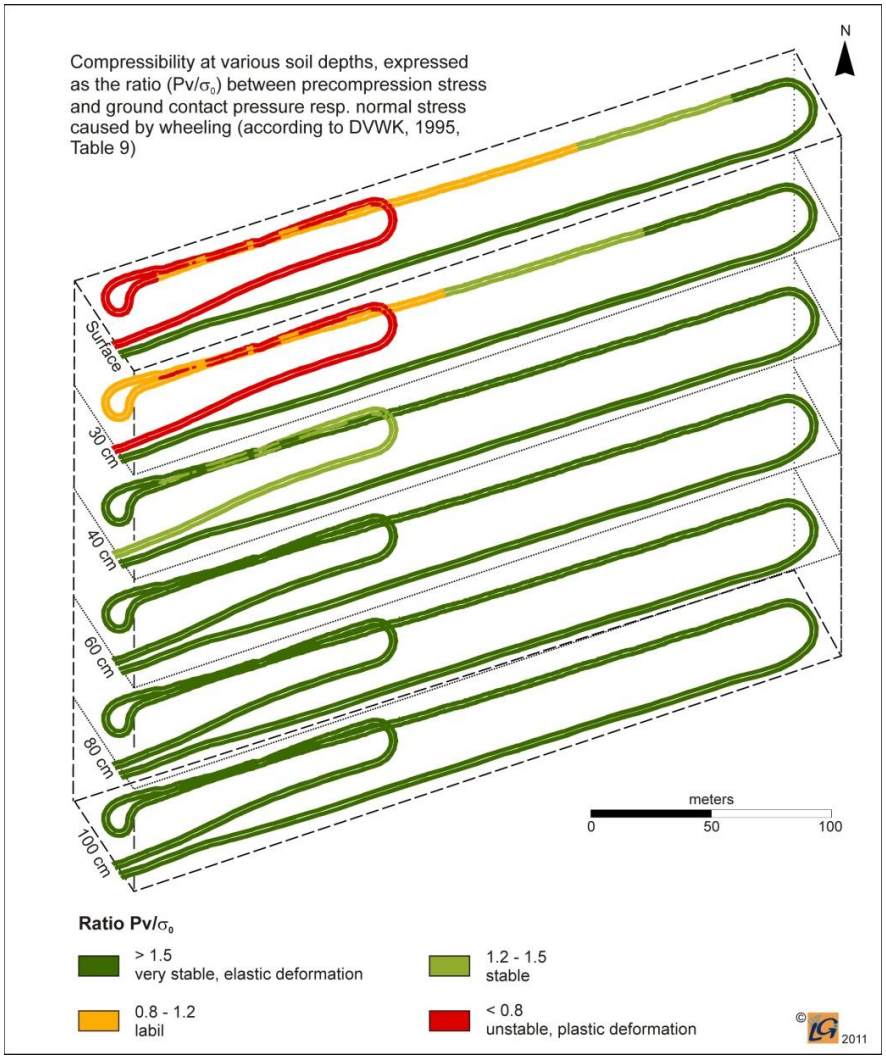
Susceptibility to soil compaction along the wheel tracks of a transportation vehicle (n. DVWK, 1995)



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Summary and Outlook

1. die räumliche Abbildung von Spurmustern auf der Grundlage von GPS-Daten ermöglicht das Detektieren und die kartographische Abbildung von Schwer-punktbereichen mit hoher mechanischer Bodenbelastung,

2. durch die Kopplung der Fahrzeugparameter mit den aus GPS-Daten generierten Fahrspuren lassen sich die Lasteinträge in Böden flächendifferenziert quantifizieren und kartographisch räumlich exakt abbilden,

3. durch den Vergleich der in den Boden eingetragenen Lasten/Drücke mit der mechanischen Belastbarkeit des Bodens lassen sich die Verdichtungsrisiken durch Befahrung mit unterschiedlichen Radlasten und Kontaktflächendrücken flächenbezogen abschätzen,

4. die 3D-Visualisierung der Effekte des mittels GPS erfassten Ernte- und Transportverkehrs kann der Entscheidungsunterstützung bei der Wahl optimalen Befahrungsstrategie dienen,

5. Ziel künftiger Arbeiten ist der Aufbau eines Server-GIS-basierten SDSS zur Optimierung des Ackerverkehrs unter Einsatz von "user-generated data ".