Automatic wheel load control system as a contribution to improve soil protection and technical trafficability

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investition in Ihre Zukunft !

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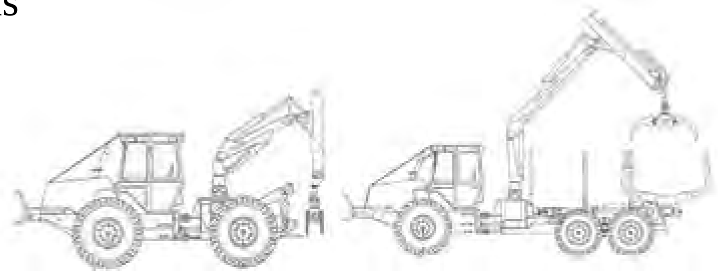
Background

- using modern (6- or 8-wheel) and high specialized forest machines is essential
  - Efficiency / Economic reasons
  - Stand conservation / soil protection
  - Just in Time supply for sawmills at al weather conditions
  - Occupational safety



- machines become heavier and more powerful
- consequence: soil compaction and deep tracks

  → permanent applied skid trail network is required

  → maintaining technical trafficability

- skid trail conservation: → increase traction / enlarge contact area

  → restrict wheel / axle load

  → equal load distribution on all wheels

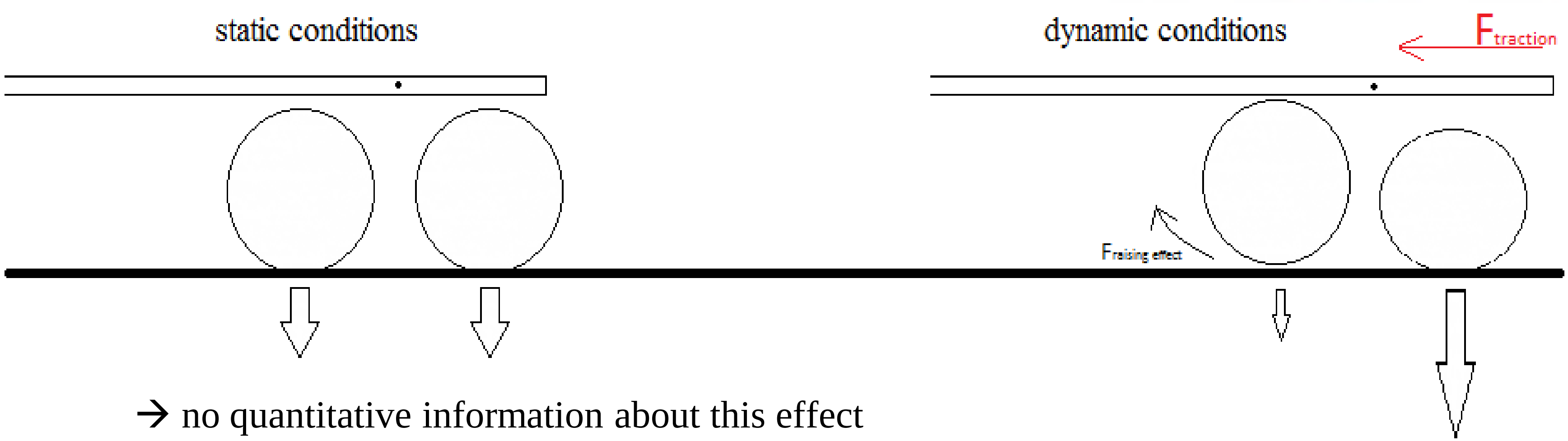
Problem

- traction force / travel movements can provoke a raising effect at a bogie axis

→ reduced wheel load at front-wheel

→ increasing wheel load at the rear-wheel

→ conventional static wheel load calculation is misleading



→ no quantitative information about this effect

Objective

- Characterize the variability of wheel load changes, induced by changing traction force
- Developing an automatic wheel load control system (*WLCS*) for a forest machine with bogie axis
- Scientific verification of the wheel load control system *(WLCS)* and its effect of soil protection and technical trafficability

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technical trafficability

Material and Methods

- 6-wheel universal skidder (Type: Welte 130K)

- 4 weighing platforms
  - → range from 50 to 10.000 kg, 50 kg steps and a tolerance of +/- 50 kg

- Traction force measuring instrument
  - → range from 0 to 220 kN in 1 kN steps

- Troxler 3440 nuclear density gauge

Material and **Methods**

- Characterization the variability of wheel load changes, induced by changing traction force

→ bogie axis wheels positioned on 4 weighing platforms

→ test machine was fixed with a 30 mm non elastic steel cable

→ displayed weights were noted under static conditions

→ Increasing traction forces were applied (driving against the steel cable) until max. ~105 kN

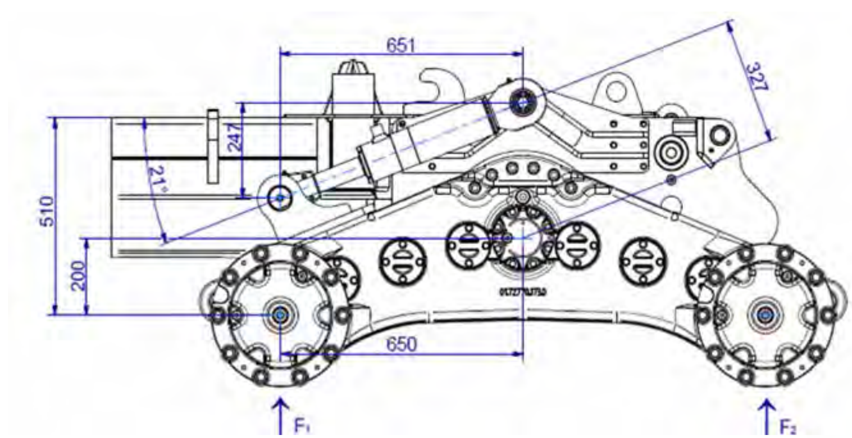
→ displayed weight of each wheel was noted

Material and Methods

- Developing an automatic wheel load control system for a forest machine with bogie axis

→ Constuction of a hydraulic wheel load regulation cylinder

→ Programming an automatic wheel load control system (hydraulic + electronic), based on hydraulic driving pressure, the wheel load and traction force



Material and **Methods**

- Scientific verification of the
  protection and technical traf

→ Comparative meassurement

after passing the test trail with

→ 2 test sites were applied on

1. prepared field site:

   - Milling 60 cr

   - homogenous

   - free from soi

2. practice conditioned fe

Material and Methods

→ measurements of soil density with troxler 3440 nuclear density gauge at 24 transects

each transect: 9 measurements in 3 depths (10, 20, 30 cm): 648 density measurements before and 648 density measurements after passing the transects with the skidder at the same point

→ on both sites the following test scheme were applied

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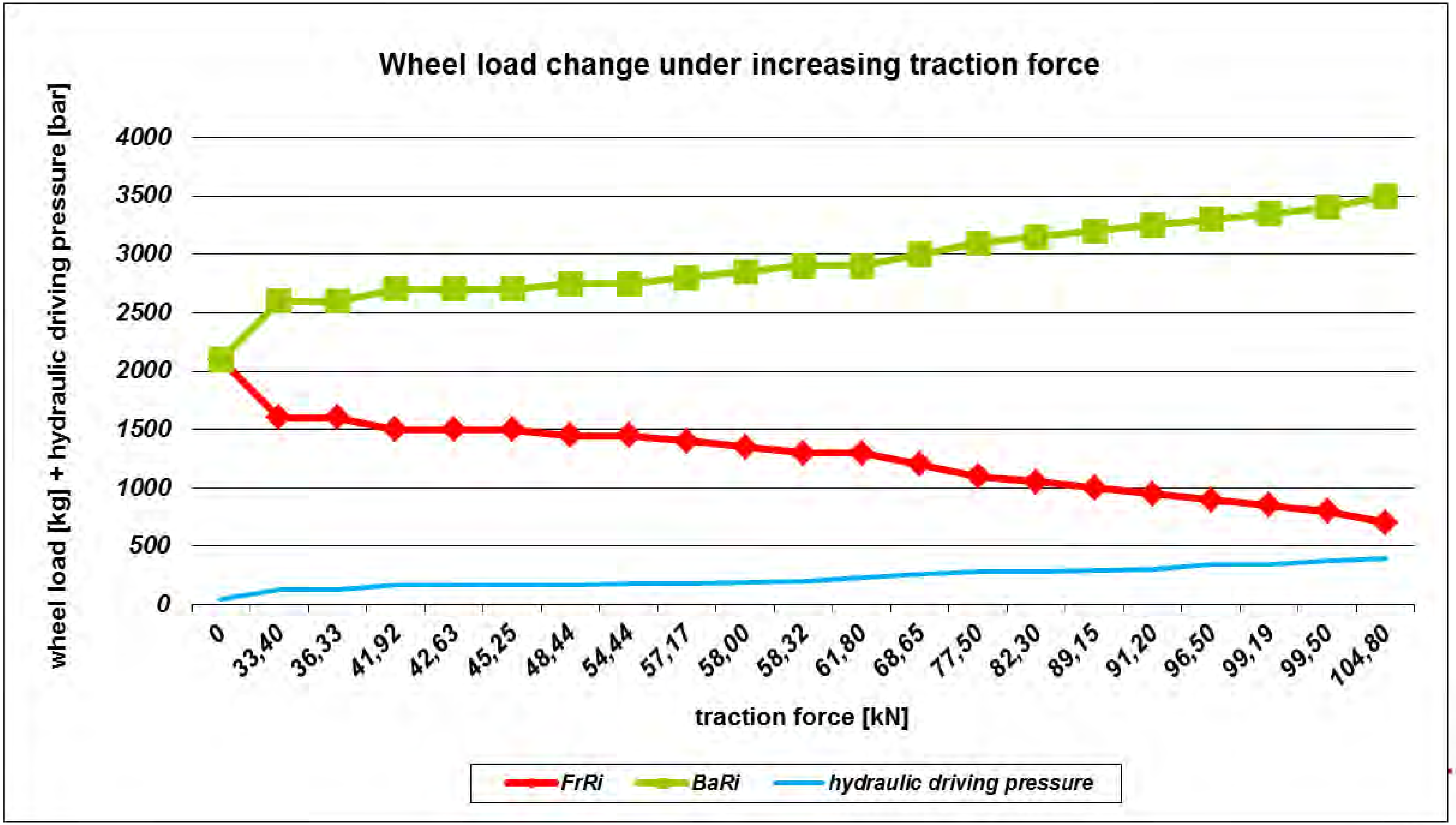
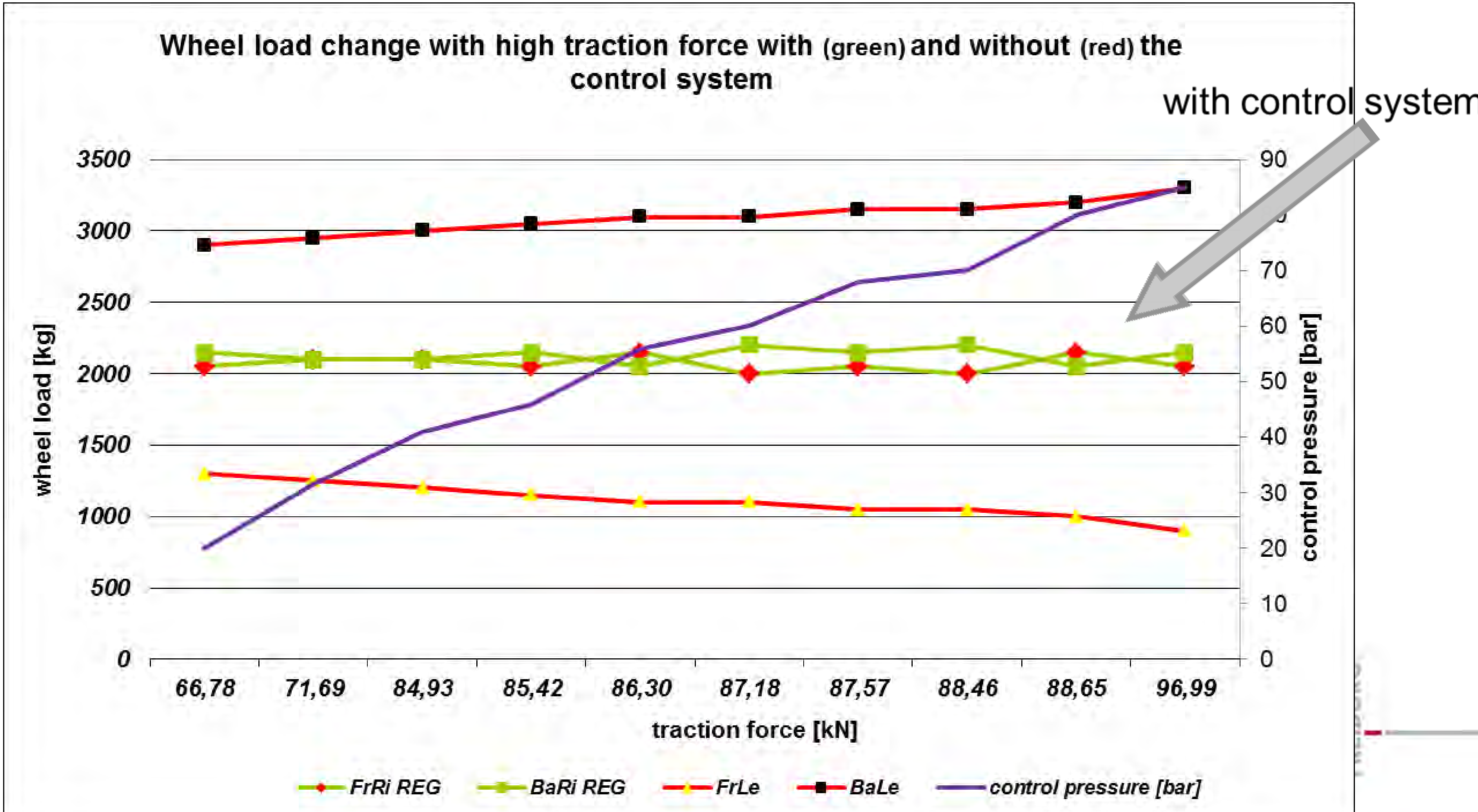
		Vehicle loaded with ~8/4 t (field/forest) short log in the timber basket			
		without WLCS		with WLCS	
Driving Mode		5 km/h $V_{const.}$	STOP&GO 0-5 km/h	5 km/h $V_{const.}$	STOP&GO 0-5 km/h
	STOP	ST 1	ST 2	ST 3	ST 4
		4 m	4 m	4 m	4 m
75 m	TF 3	Transect 3	Transect 6	Transect 9	Transect 12
50 m	TF 2	Transect 2	Transect 5	Transect 8	Transect 11
25 m	TF 1	Transect 1	Transect 4	Transect 7	Transect 10
	START				

Results: **Characterization the variability of wheel load changes**



Results: **Characterization the variability of wheel load changes**



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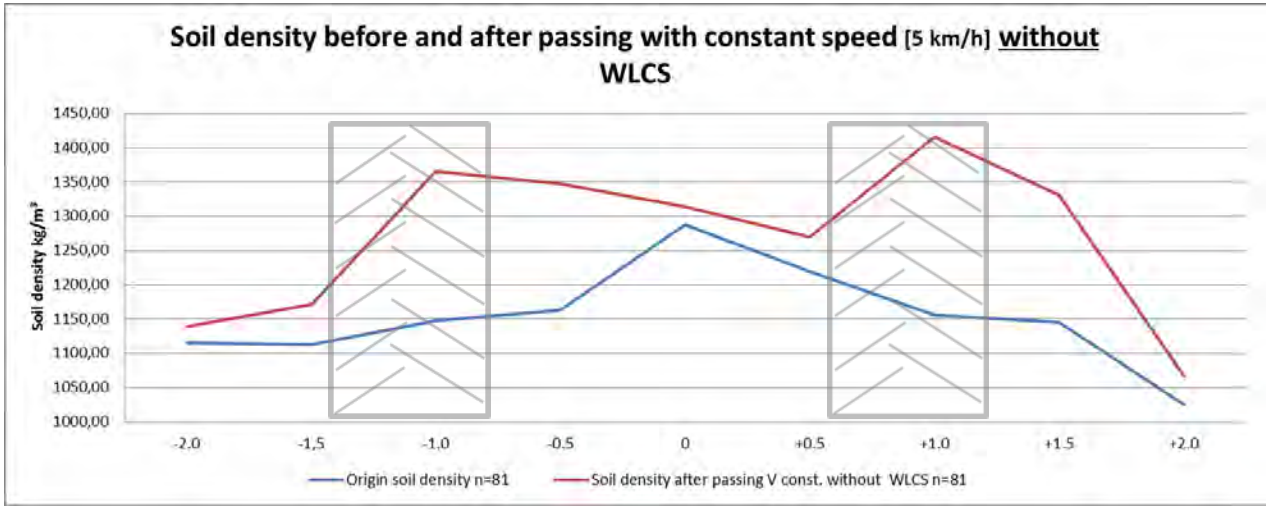
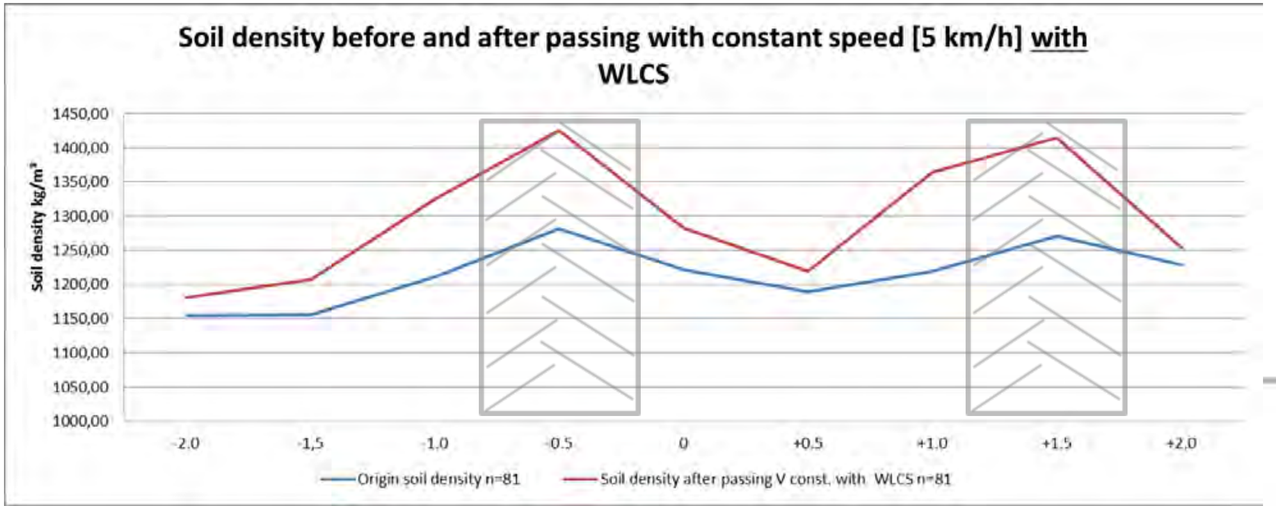
Results: **Scientific verification of the wheel load control system: Prepared field site**



212 kg/m²

1153 kg/m³ → 1365 kg/m³

~ 118 %

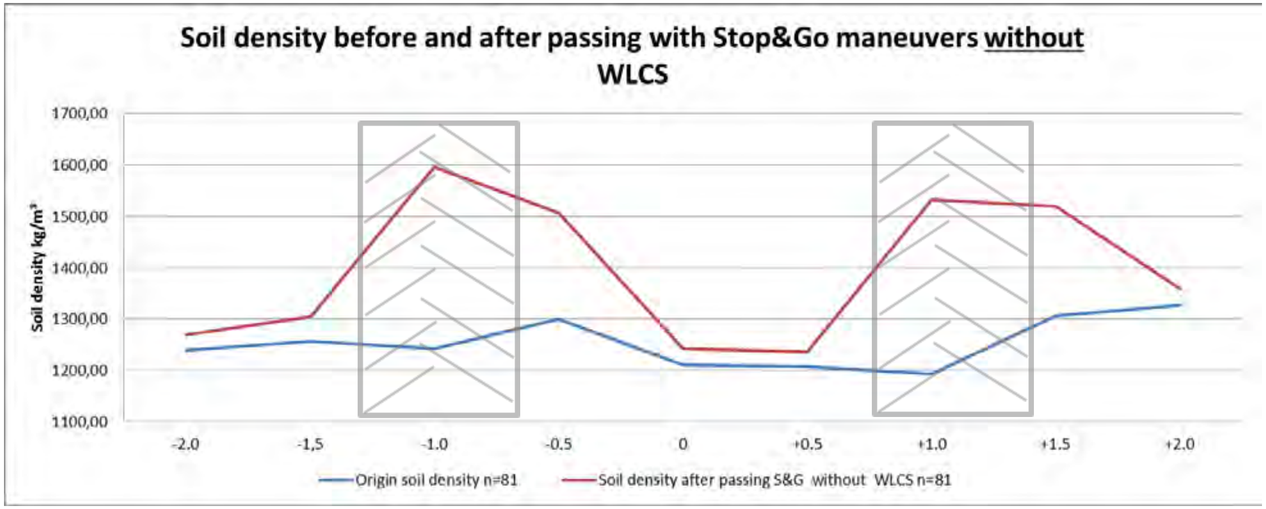


136 kg/m³

1246 kg/m³ → 1382 kg/m³

~ 111 %

Results: **Scientific verification of the wheel load control system: Prepared field site**



278 kg/m²

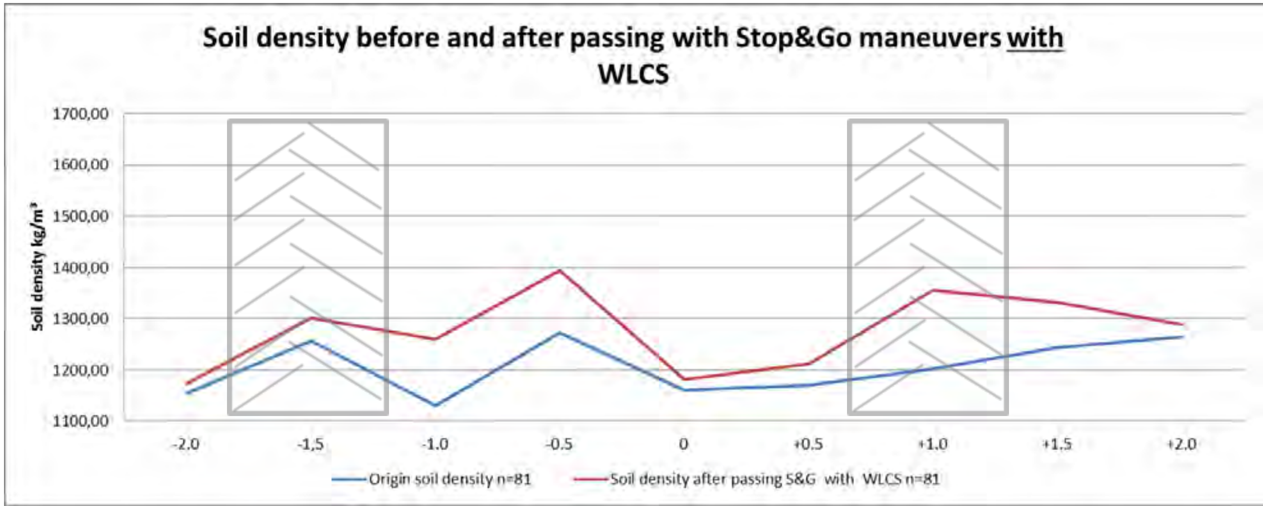
1260 kg/m³ → 1538 kg/m³

~ 122 %

124 kg/m³

1212 kg/m³ → 1336 kg/m³

~ 110 %



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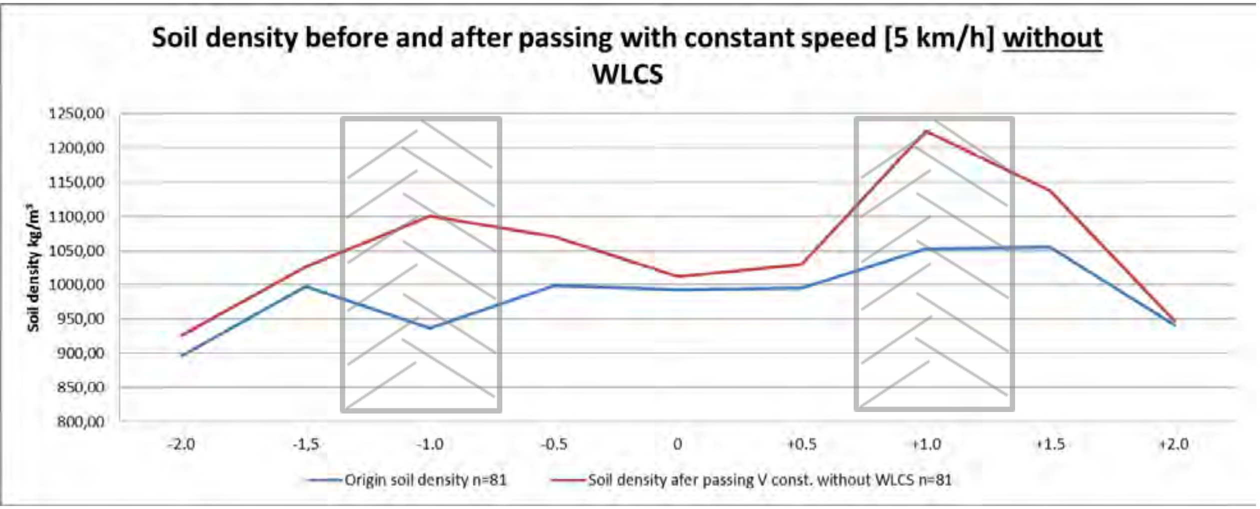
Results: **Scientific verification of the wheel load control system: Forest site**



122 kg/m²

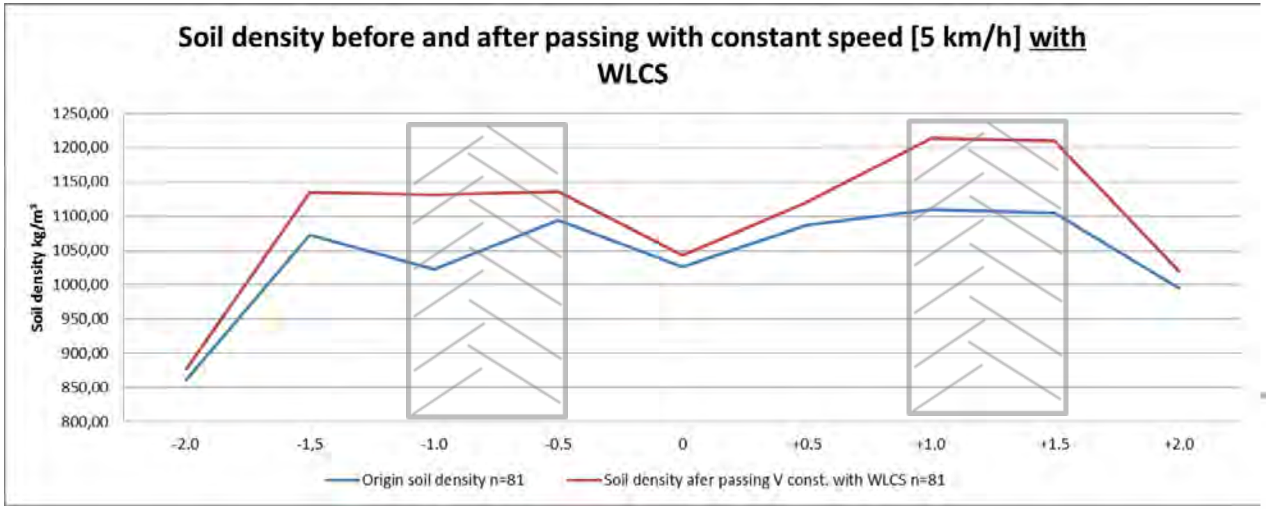
1011 kg/m³ → 1133 kg/m³

~ 112 %

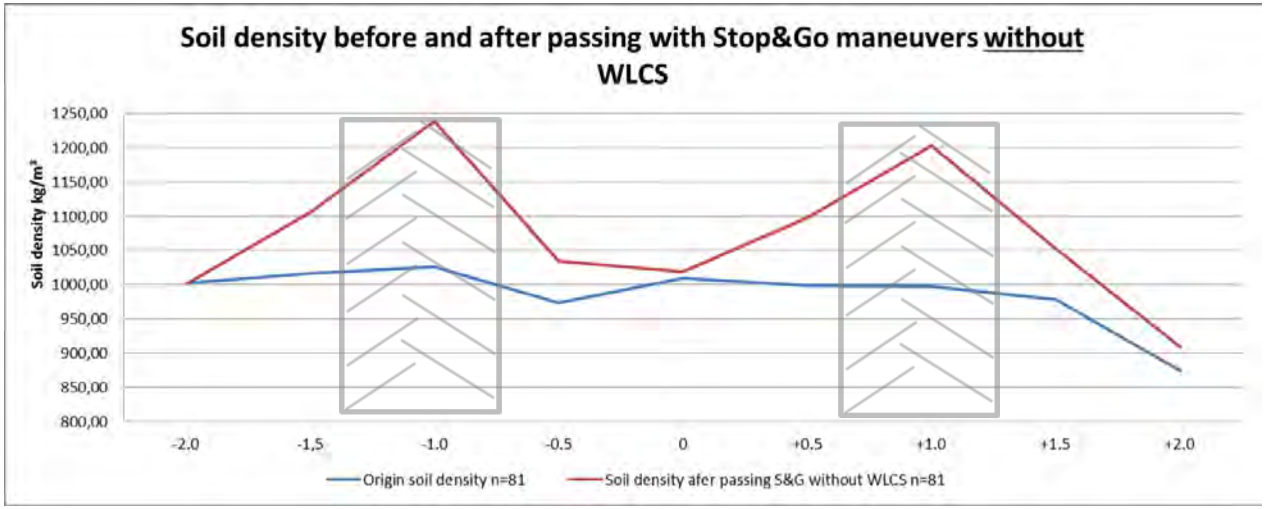
90 kg/m³

1083 kg/m³ → 1173 kg/m³

~ 108 %



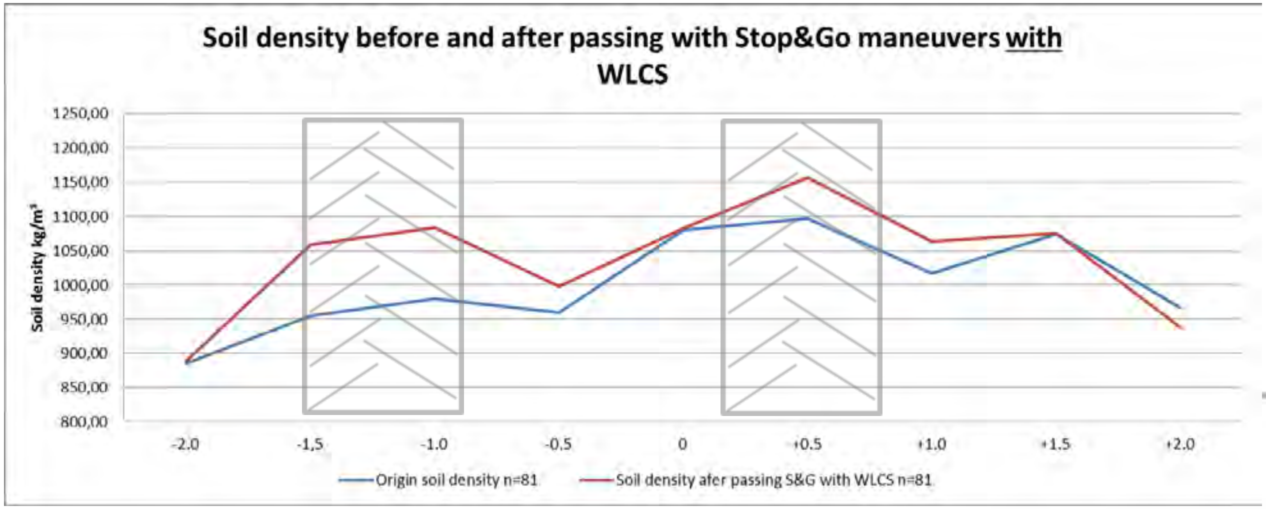
Results: **Scientific verification of the wheel load control system: Forest site**



151 kg/m²

1010 kg/m³ → 1161 kg/m³

~ 115 %

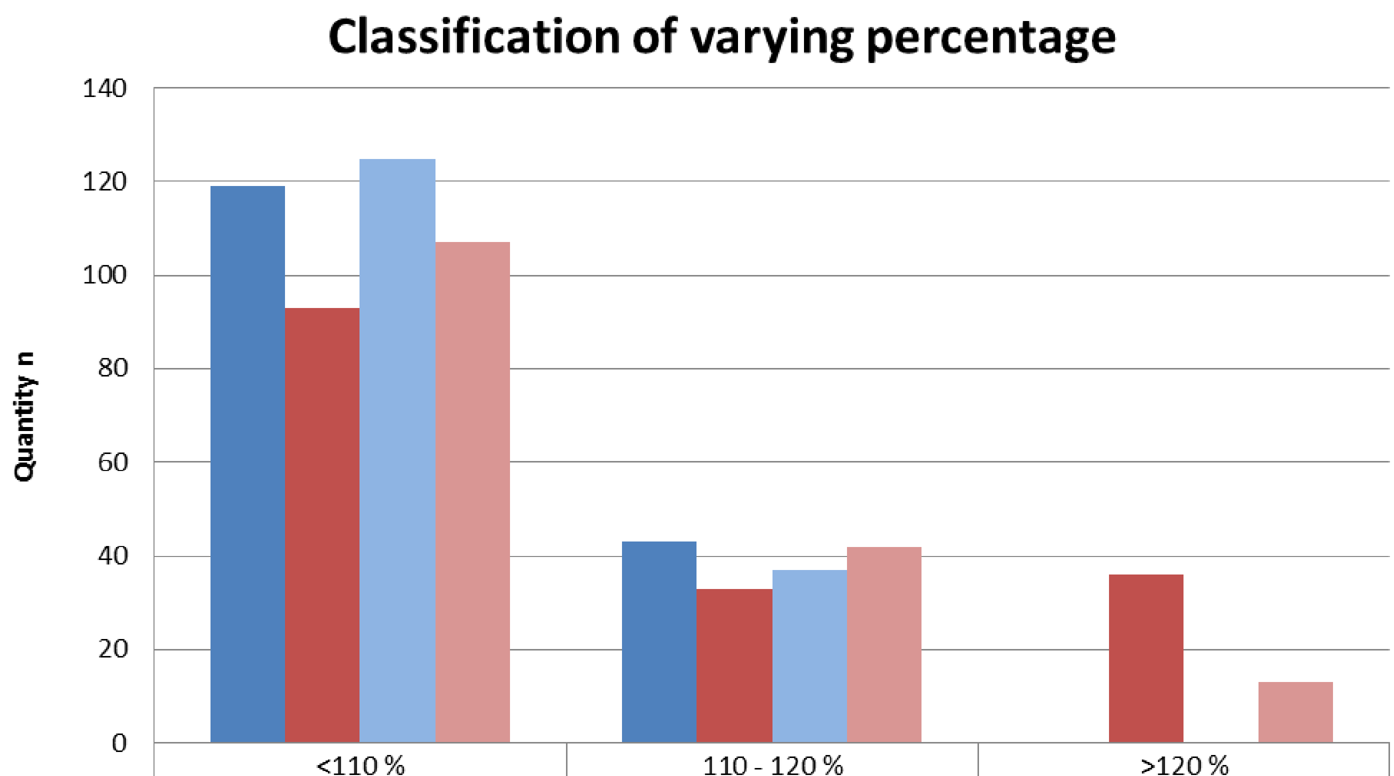


78 kg/m³

1012 kg/m³ → 1090 kg/m³

~ 108 %

Results: **Scientific verification of the wheel load control system: Resume**



	<110 %	110 - 120 %	>120 %
Field with WLCS	119	43	0
Field without WLCS	93	33	36
Forest with WLCS	125	37	0
Forest without WLCS	107	42	13

Conclusion:

→ significant change of the static wheel load distribution caused by traction force

→ dynamic effects have to be considered if effective ground pressure is calculated !

→ WLCS can be a contribution to improve soil protection

~ 35 % (min.) lower soil compaction on our practice conditioned forest site

Thank you for your attention

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