

Interreg



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Sít' výzkumných institucí a podniků pro infrastrukturu

**Wissenschafts- und
Unternehmensnetzwerk für
Umwelt und Infrastruktur**



Zohlednění přírodě blízkých řešení při odhadu stability svahů v rozsáhlých oblastech

Berücksichtigung von naturbasierten
Lösungen in die Einschätzung der
Böschungstabilität in großen Gebieten

Lukáš Zedek

3. 12. 2024



Krajina zasažená těžbou

Důl Nochten

Bergbaufolgelandschaft

Tagebau Nochten



Posuzovaná lokalita



Eingeschätzte Standort

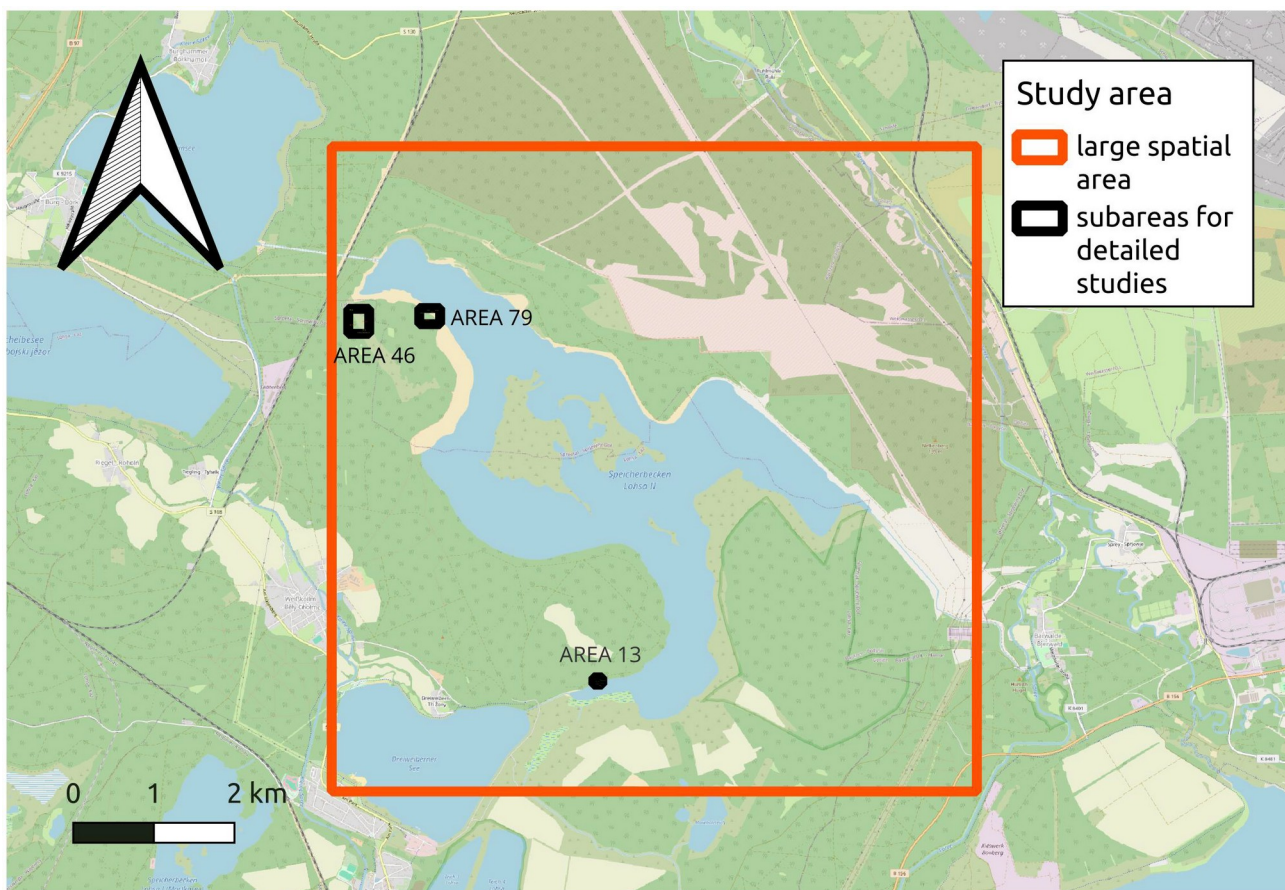


Posuzovaná lokalita

Lužická jezera,
Vodní nádrž
Lohsa II

Eingeschätzte Standort

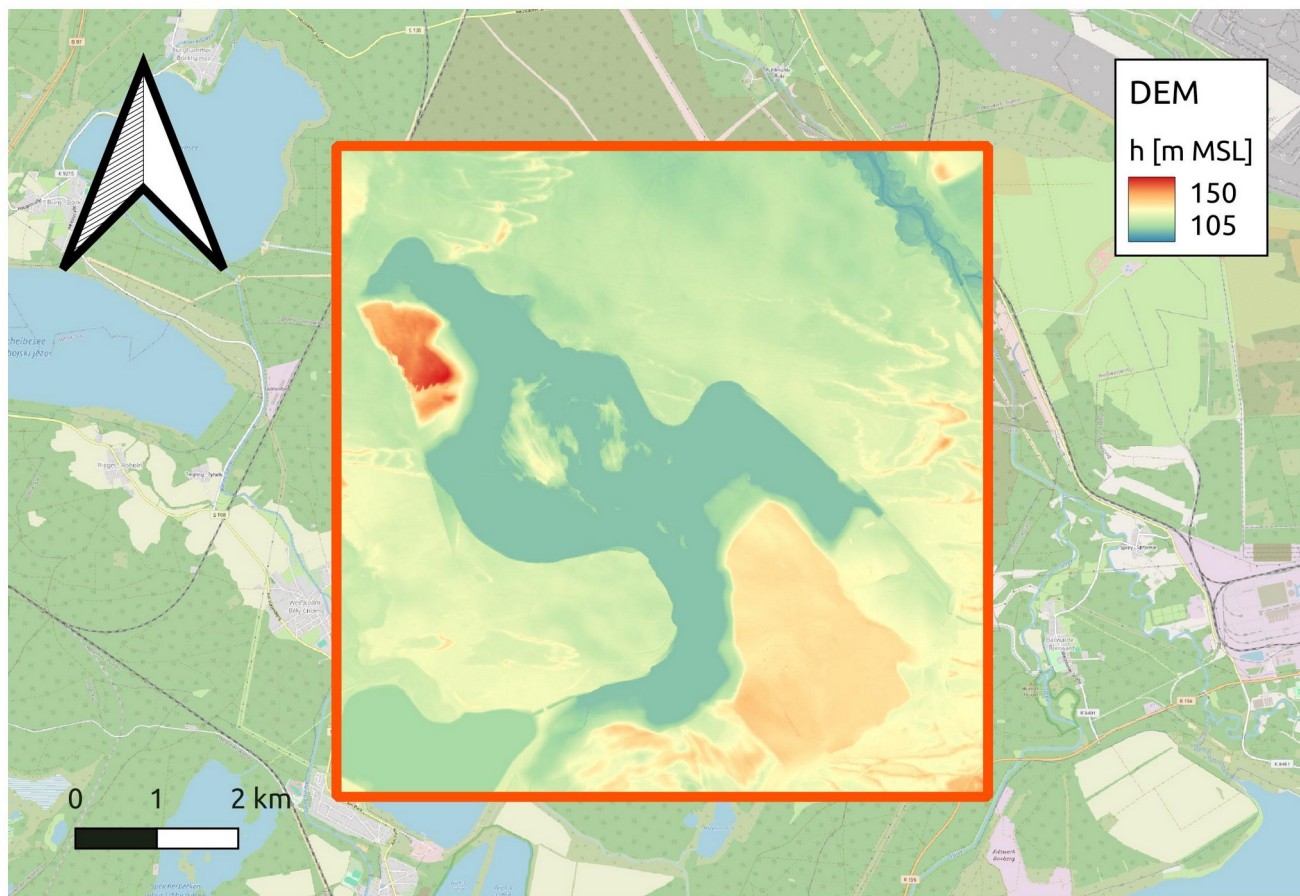
Lausitzer
Seenland,
Speicherbecken
Lohsa II



Digitální Model Reliéfu

Digital Geländemodell

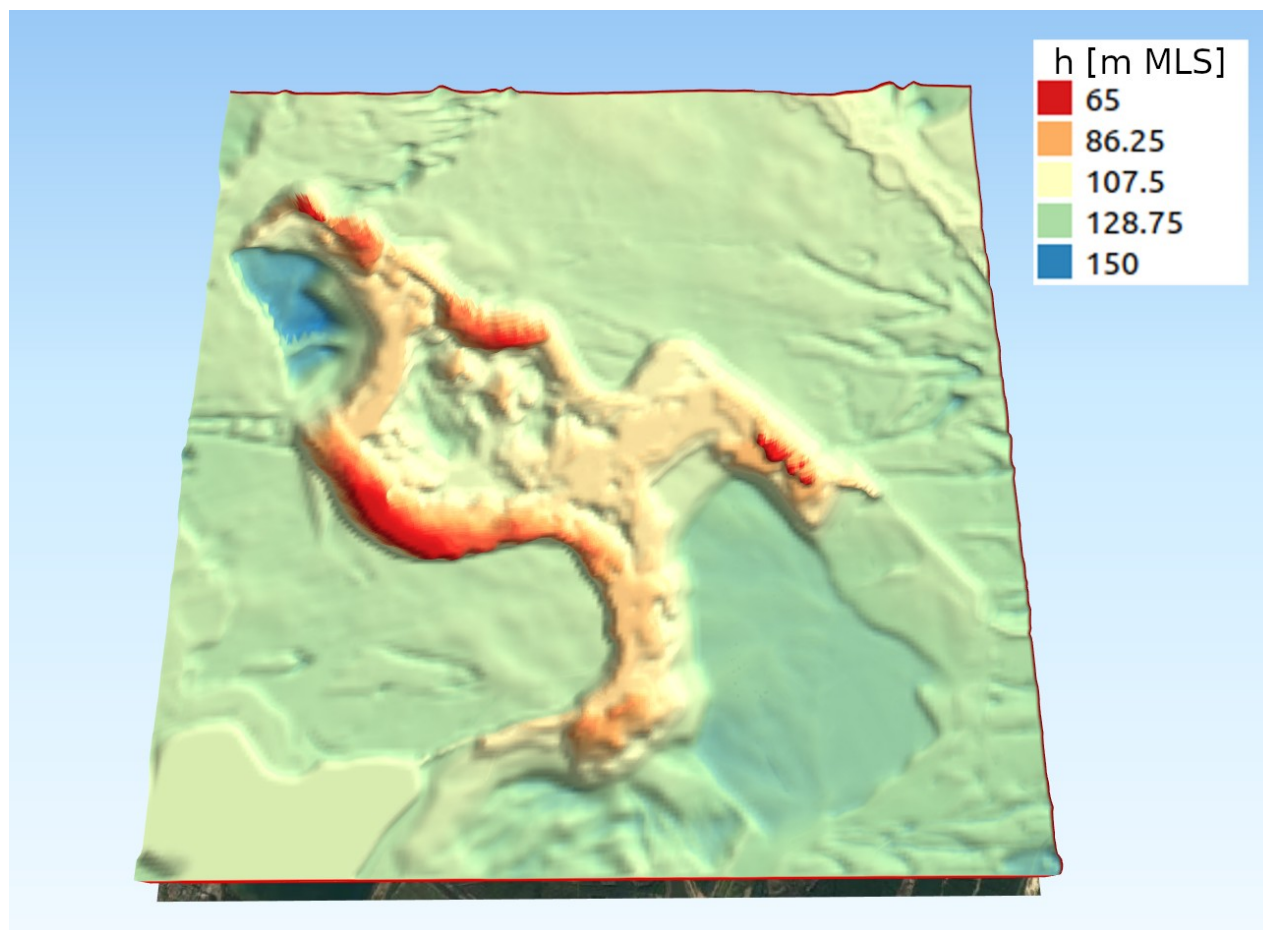
Vodní nádrž
Lohsa II



Speicherbecken
Lohsa II

Digitální Model Reliéfu

Digital Geländemodell

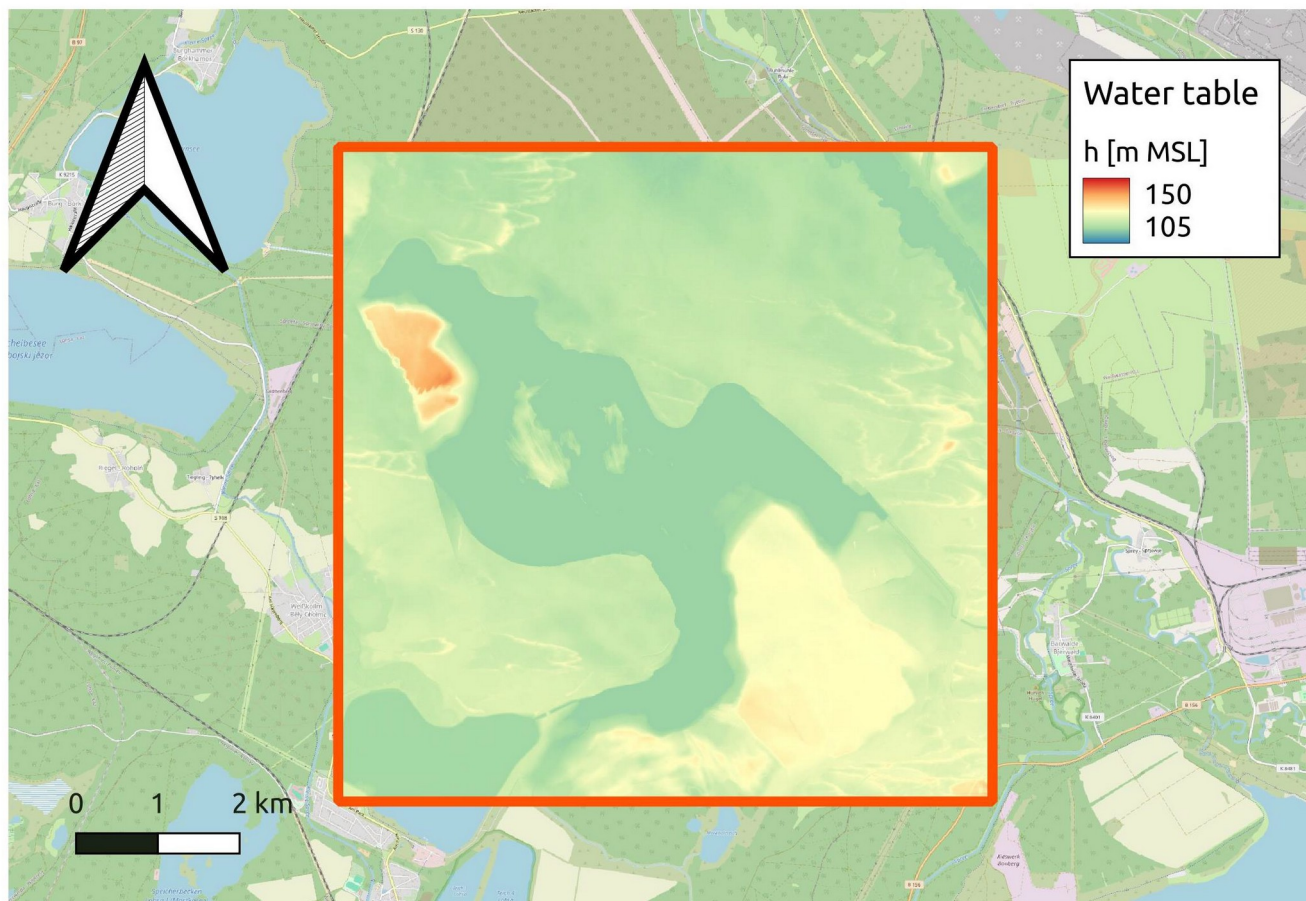


Vodní hladina

Wasserspiegel

Vodní nádrž
Lohsa II

Speicherbecken
Lohsa II



Typ zemin



Bodentyp



Typ zemin s kořeny

R-oots => kořeny



Bodentyp mit Wurzeln

R-oots => Wurzeln

Typ zemin s kořeny

Bodentyp mit Wurzeln

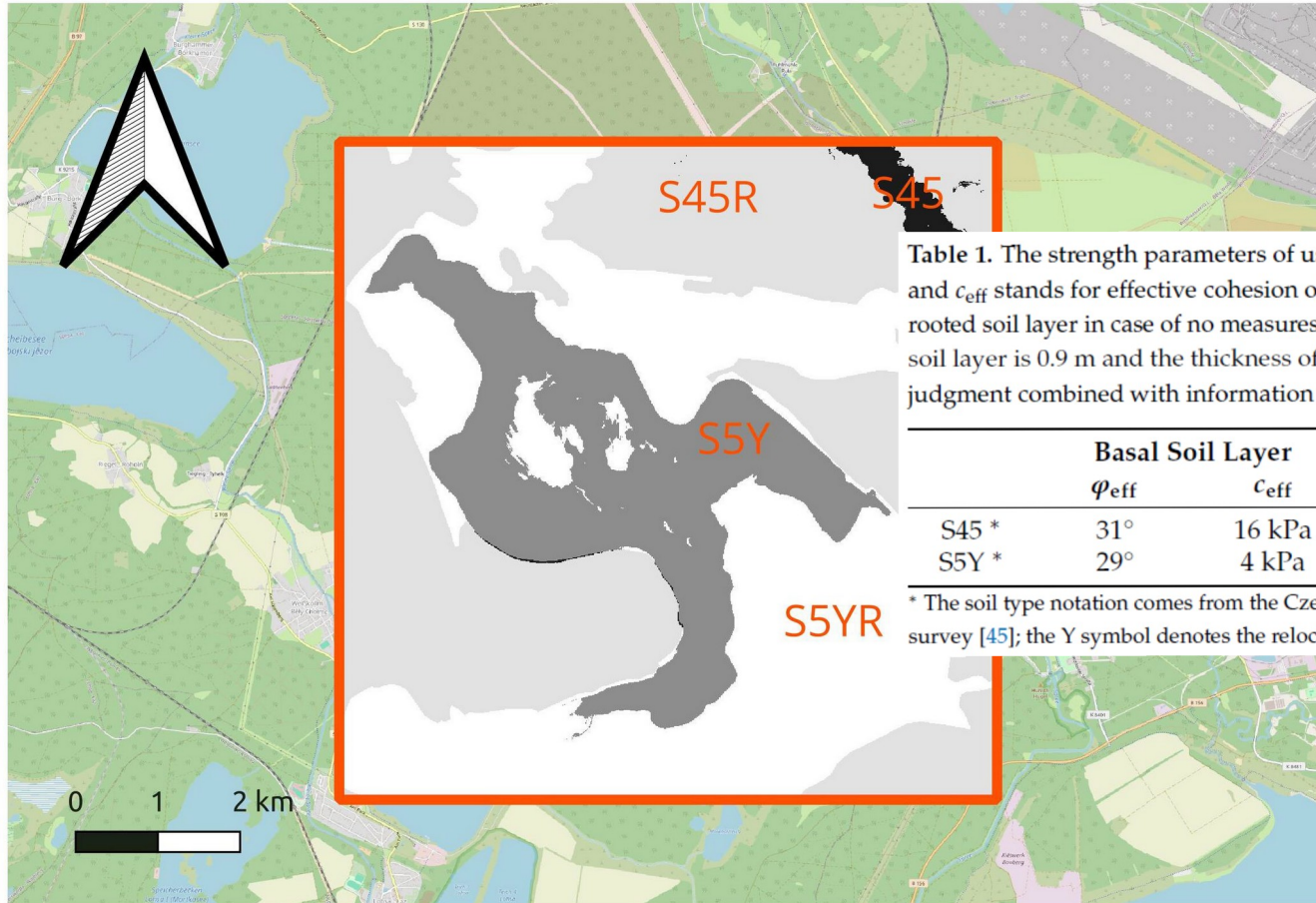
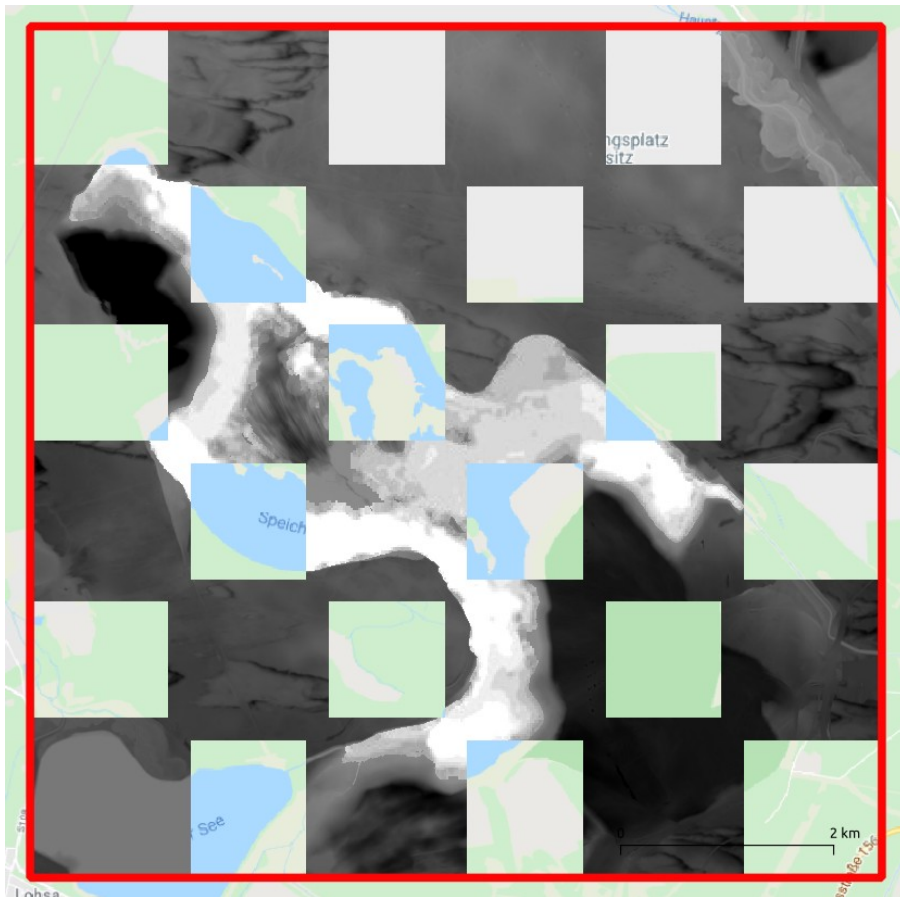


Table 1. The strength parameters of used soil types. φ_{eff} denotes effective angle of internal friction and c_{eff} stands for effective cohesion of soil. The thickness of the topsoil layer is 5 m and there is no rooted soil layer in case of no measures. In the case of 0.9 m rooting depth, the thickness of the rooted soil layer is 0.9 m and the thickness of topsoil layer is 4.1 m. Parameter values are based on expert judgment combined with information from the literature [34,35,37].

	Basal Soil Layer		Topsoil Layer		Rooted Soil Layer	
	φ_{eff}	c_{eff}	φ_{eff}	c_{eff}	φ_{eff}	c_{eff}
S45 *	31°	16 kPa	27°	8 kPa	27°	24 kPa
S5Y *	29°	4 kPa	25°	2 kPa	25°	18 kPa

* The soil type notation comes from the Czech Technical Standard ČSN P 73 1005 (731005) Engineering geological survey [45]; the Y symbol denotes the relocated material in non-original placement.

Překryv



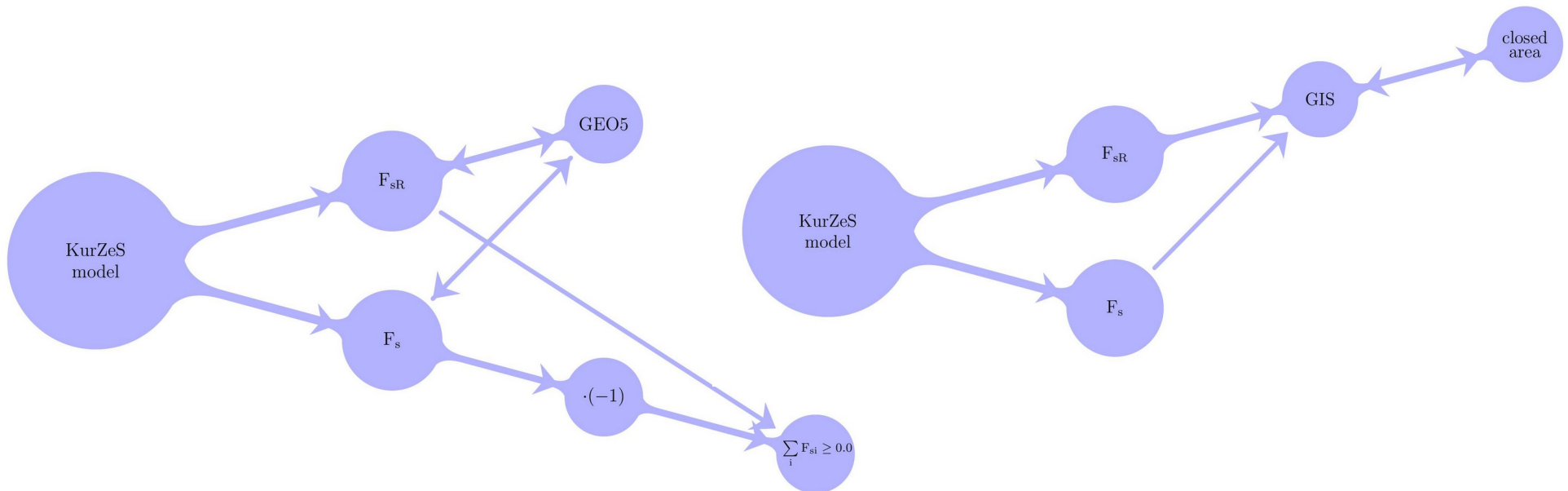
Überlappung

Intel® Core™ i7-3770K CPU; 3.50GHz × 4,
RAM 15.5 GiB,
Ubuntu 18.04.4 LTS,
Python 3,
4 vlákna / Threads,
36 podoblastí / kleinere Gebiete 1500x1500 m
4 výpočty = 14 minutes / 4 Berechnungen = 14
Minuten.

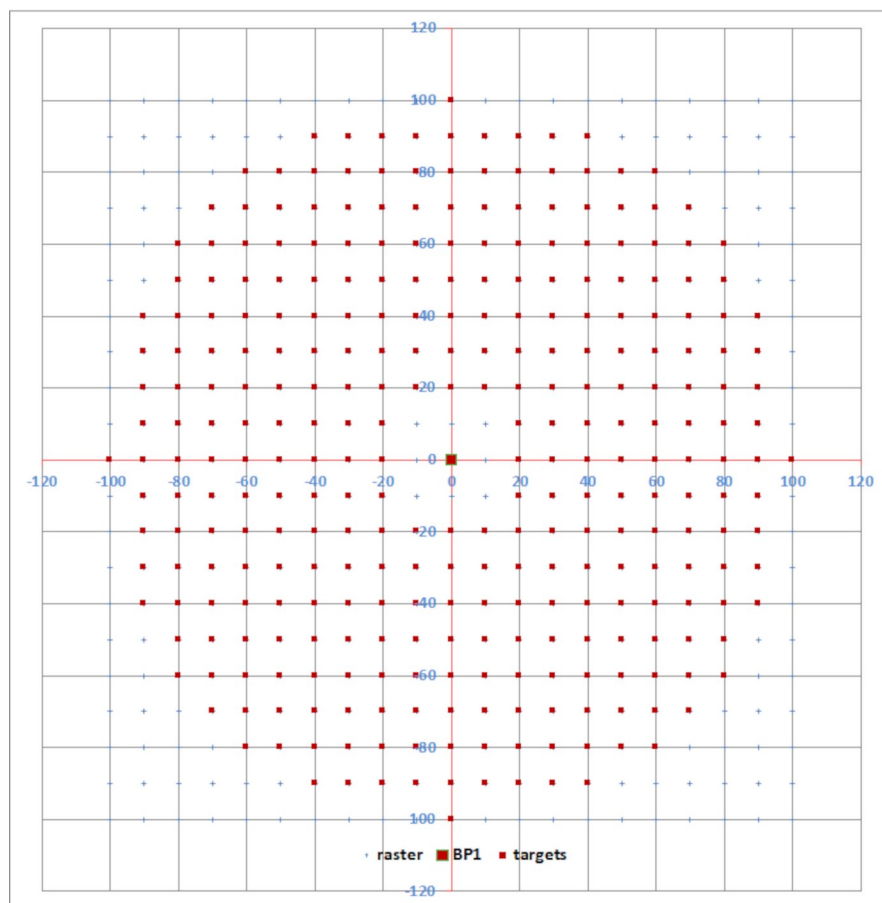
```
import multiprocessing as mp
```

Verifikace a validace

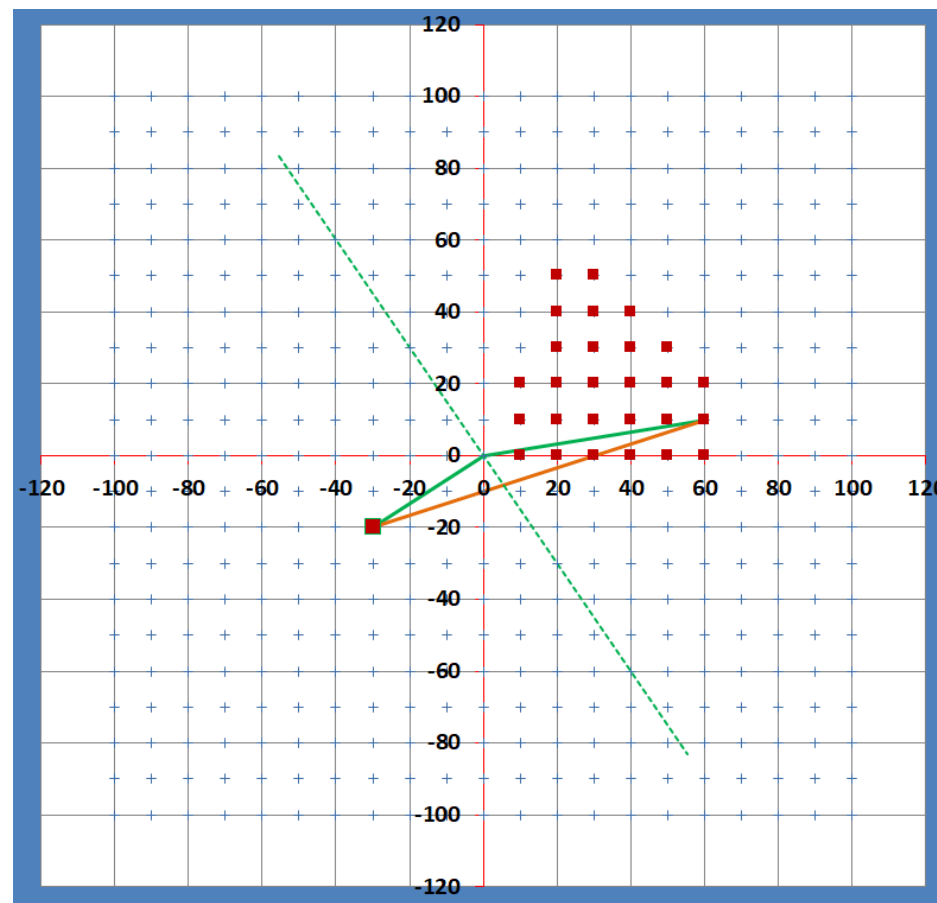
Verifizierung und Validierung



Geometrický koncept

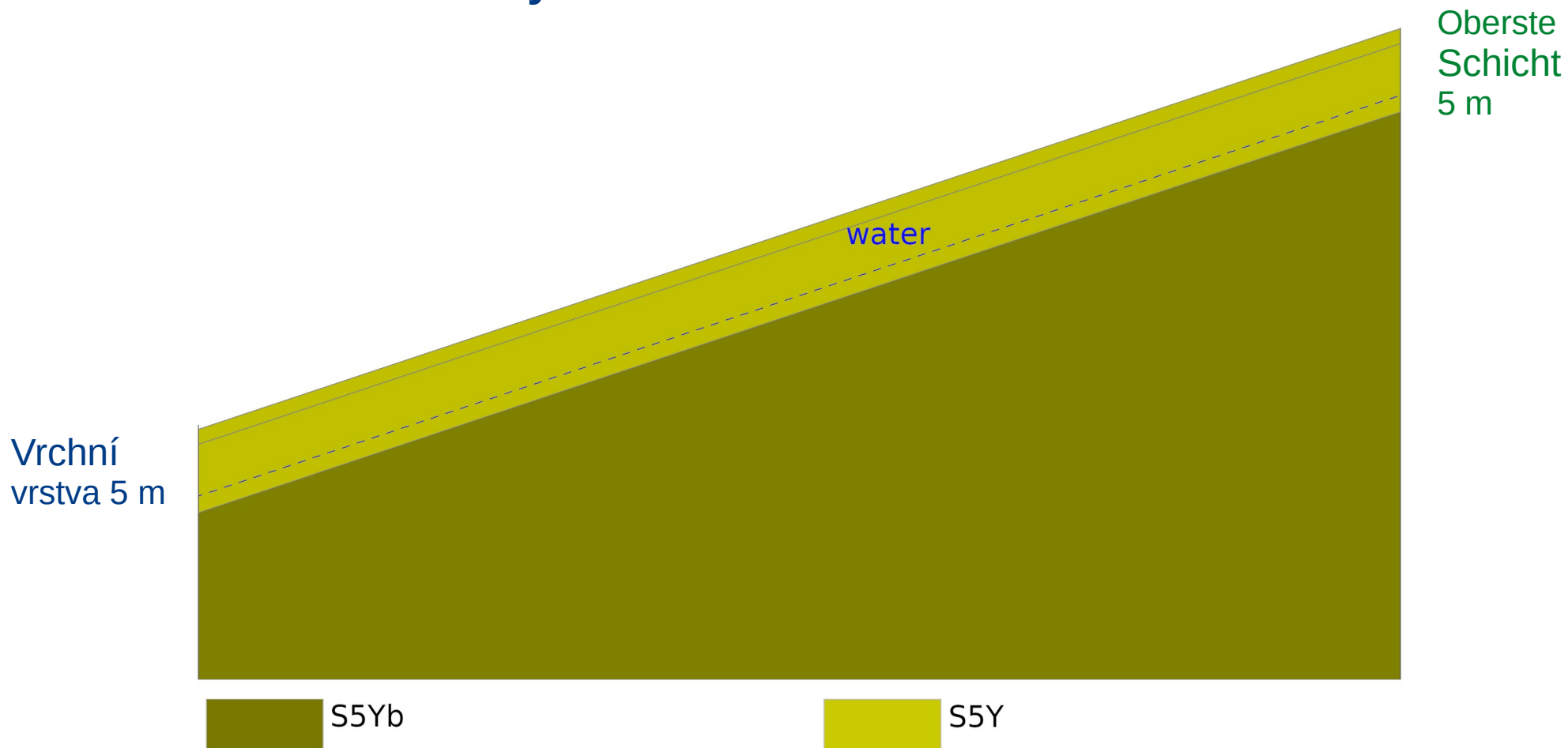


Geometrische Konzeption



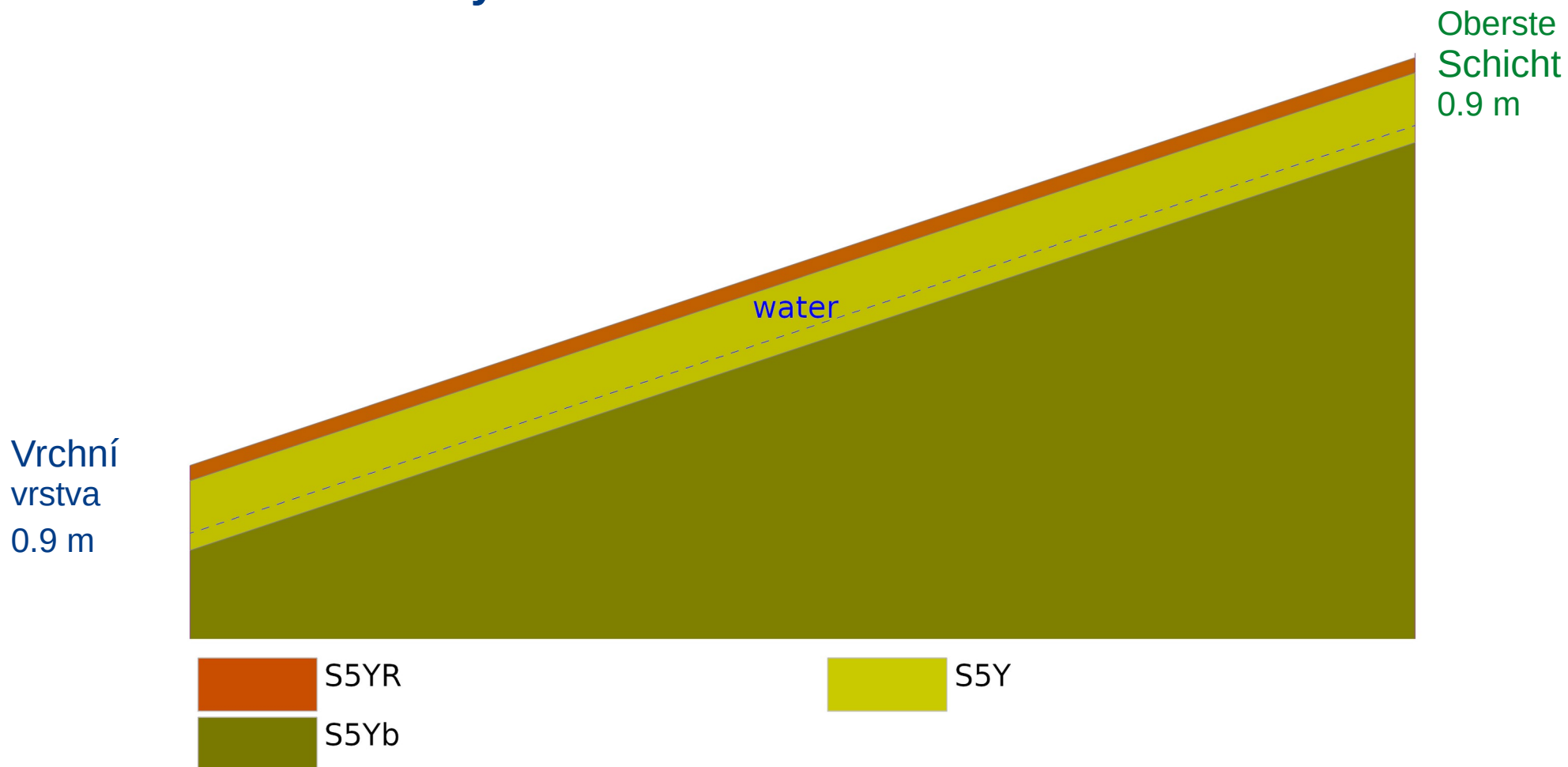
Dvouvrstvý model

Zweischichten-Modell



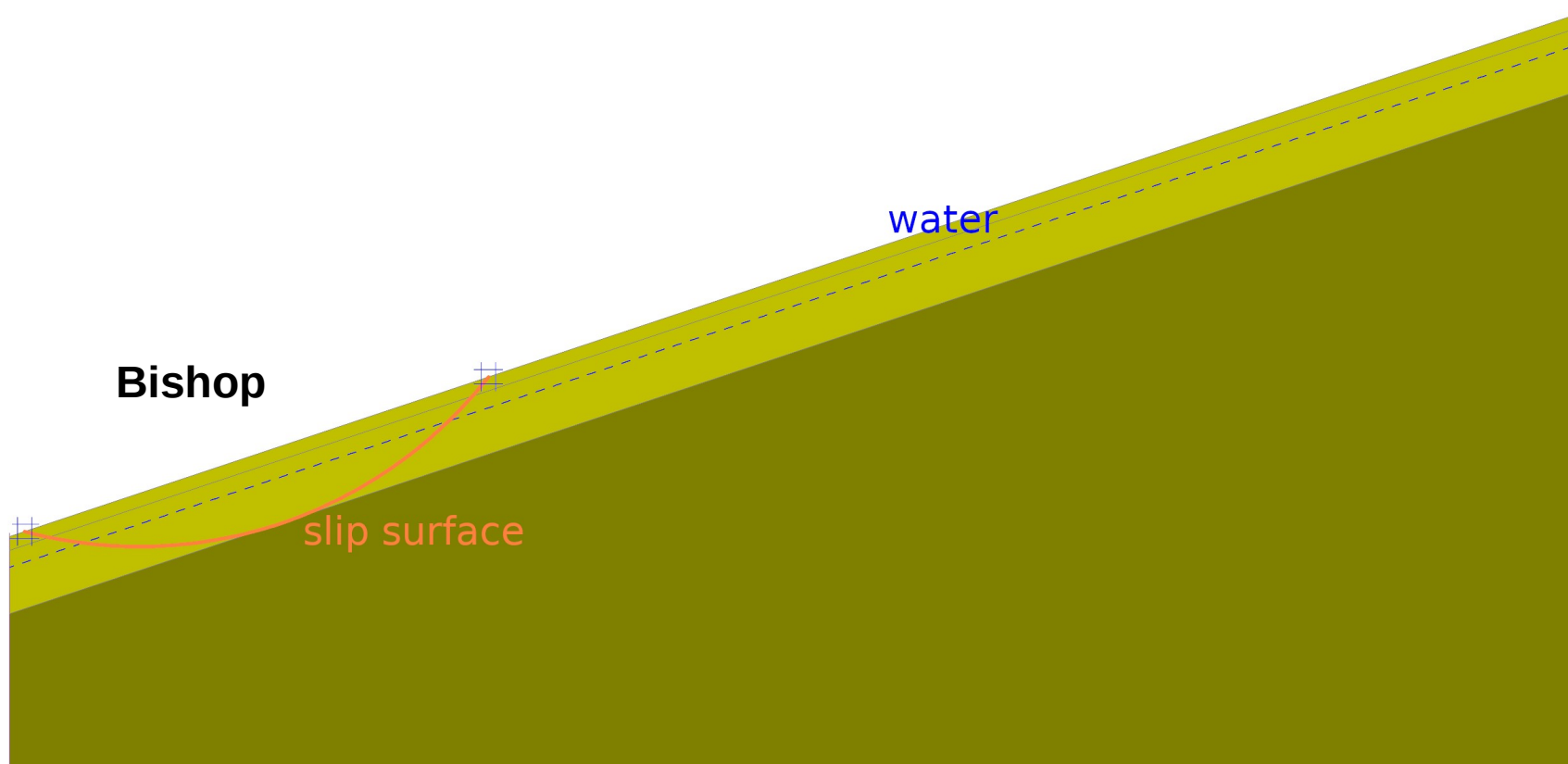
Třívrstvý model

Dreischichten-Modell



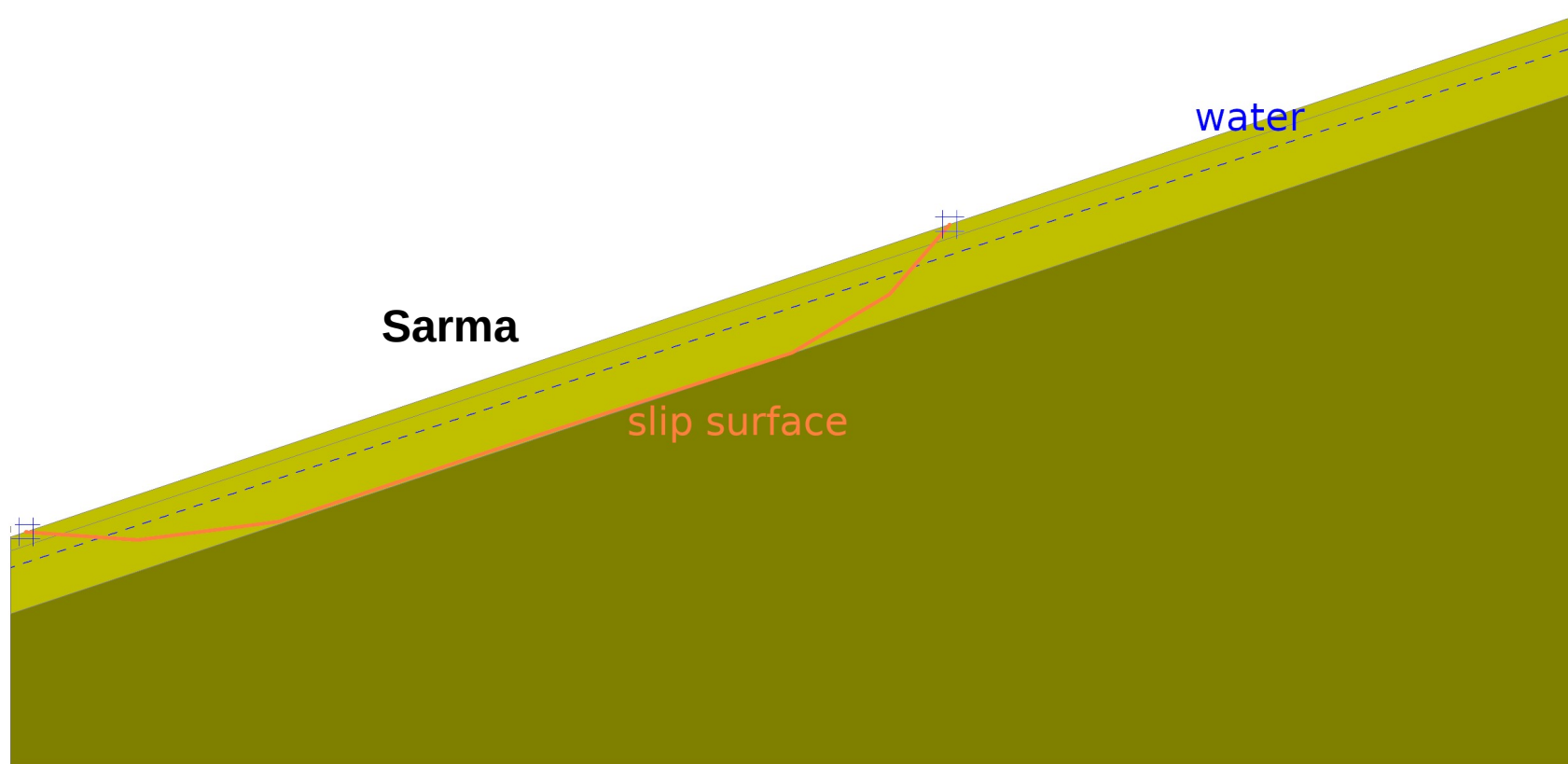
Krátká smyková plocha

Kurze Scherfläche



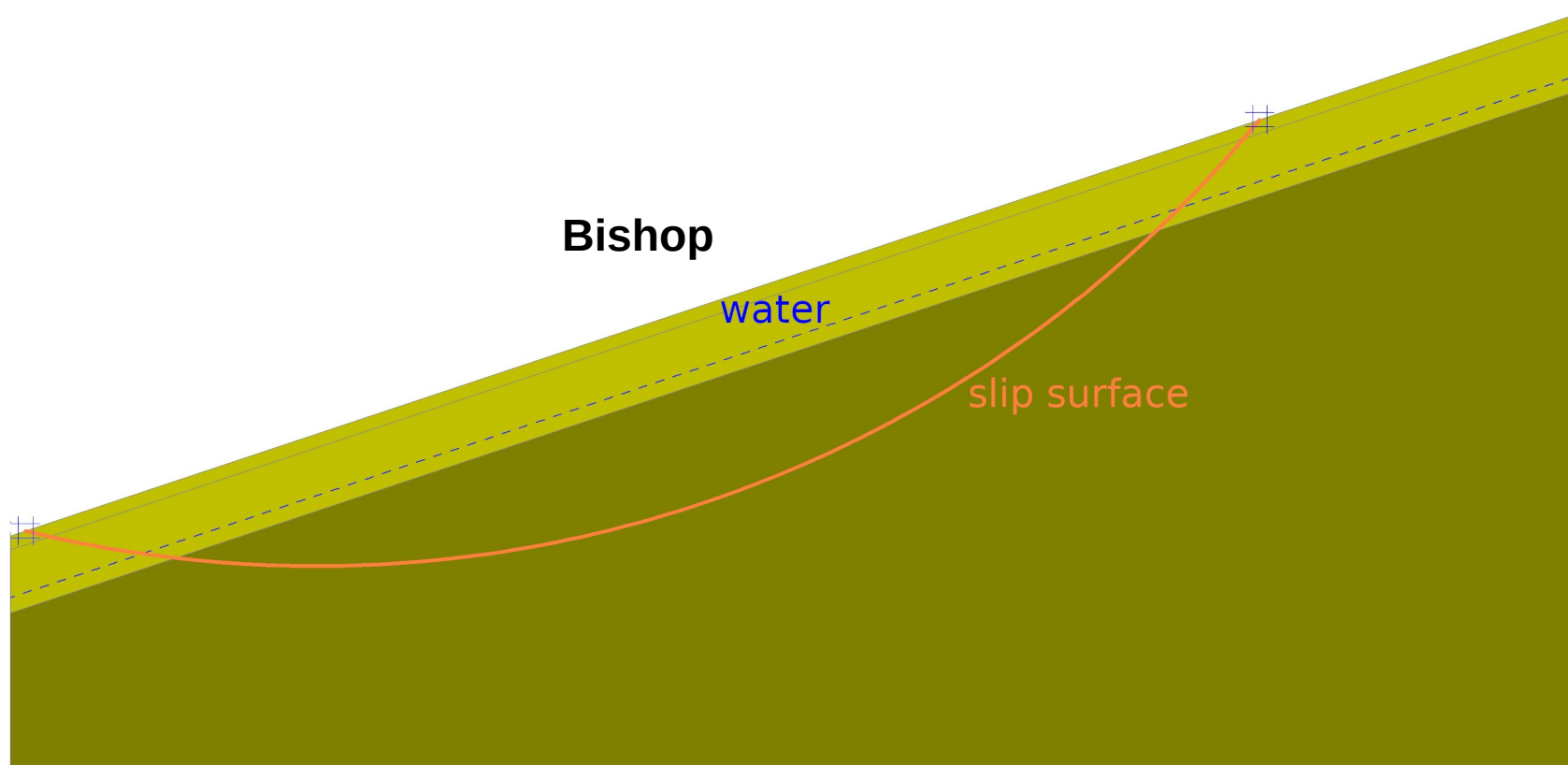
Středně dlouhá smyková plocha

Mittel-lange Scherfläche



Dlouhá smyková plocha

Lange Scherfläche



Databáze

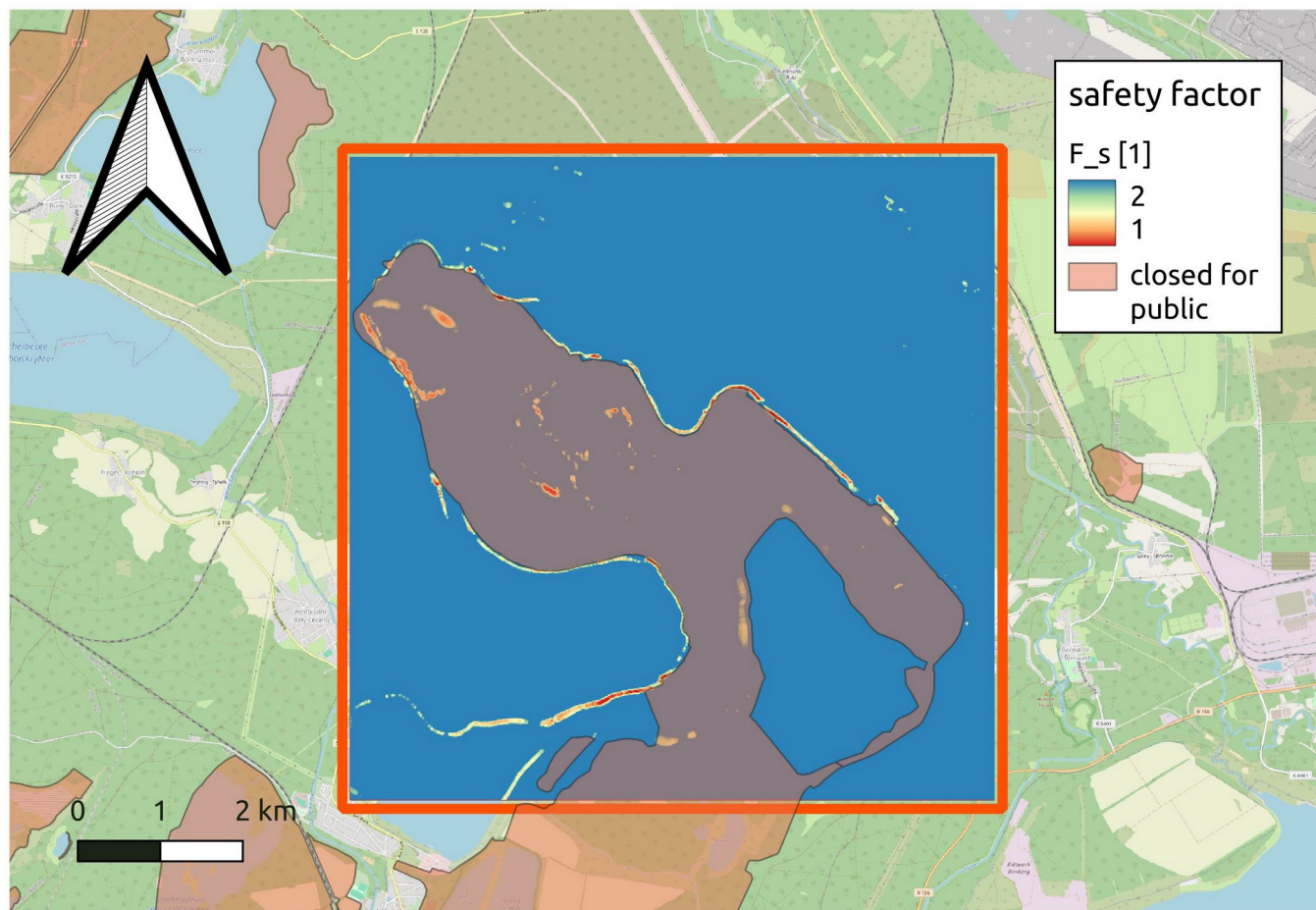
SSY			ϕ_{eff}	C_{eff}	V	V_{sat}		
	1		25	2	19	19.5		
	1plus		29	4	20	20.5		
			25	18	19	19.5		
gndwater	1 in ?		20	30	40	60	80	100
-20	3		1.75	1.66	1.62	1.56	1.54	1.52
-6	3		1.75	1.67	1.62	1.56	1.53	1.49
-4	3		1.75	1.66	1.57	1.49	1.43	1.35
-3	3		1.75	1.53	1.44	1.35	1.29	1.27
-2	3		1.58	1.36	1.28	1.18	1.13	1.12
-1	3		1.31	1.16	1.08	1.01	0.99	0.96
0	3		0.97	0.90	0.86	0.82	0.80	0.79
-20	4		2.33	2.22	2.15	2.08	2.04	2.02
-6	4		2.33	2.22	2.15	2.08	2.04	2.00
-4	4		2.33	2.22	2.09	1.96	1.90	1.80
-3	4		2.33	2.05	1.92	1.78	1.73	1.69
-2	4		2.11	1.82	1.70	1.55	1.51	1.50
-1	4		1.76	1.54	1.44	1.34	1.30	1.27
0	4		1.29	1.19	1.14	1.09	1.06	1.05
-20	5		2.90	2.76	2.69	2.60	2.55	2.52
-6	5		2.90	2.76	2.69	2.60	2.55	2.50
-4	5		2.90	2.76	2.62	2.46	2.39	2.25
-3	5		2.90	2.57	2.40	2.23	2.14	2.11
-2	5		2.63	2.28	2.12	1.98	1.89	1.86
-1	5		2.18	1.93	1.80	1.68	1.62	1.60
0	5		1.60	1.49	1.42	1.36	1.32	1.30
-20	6		3.48	3.32	3.22	3.12	3.06	3.02

Datenbank

SSY			ϕ_{eff}	C_{eff}	V	V_{sat}		
	1		25	2	19	19.5		
	1plus		29	4	20	20.5		
root			25	18	19	19.5		
gndwater	1 in ?		20	30	40	60	80	100
-20	3		2.01	1.82	1.72	1.62	1.58	1.55
-6	3		2.01	1.82	1.72	1.62	1.58	1.50
-4	3		2.02	1.77	1.66	1.55	1.44	1.36
-3	3		1.93	1.63	1.53	1.40	1.33	1.28
-2	3		1.71	1.46	1.36	1.23	1.17	1.14
-1	3		1.46	1.25	1.17	1.06	1.02	0.98
0	3		1.18	1.02	0.95	0.89	0.84	0.81
-20	4		2.70	2.43	2.30	2.17	2.10	2.08
-6	4		2.70	2.42	2.30	2.17	2.10	2.01
-4	4		2.70	2.36	2.21	2.02	1.93	1.81
-3	4		2.57	2.17	2.03	1.84	1.78	1.71
-2	4		2.30	1.94	1.81	1.61	1.56	1.54
-1	4		1.96	1.66	1.55	1.41	1.35	1.31
0	4		1.56	1.34	1.26	1.16	1.16	1.09
-20	5		3.35	3.03	2.87	2.69	2.62	2.57
-6	5		3.35	3.04	2.87	2.69	2.62	2.51
-4	5		3.35	2.95	2.76	2.54	2.41	2.27
-3	5		3.20	2.73	2.54	2.32	2.20	2.13
-2	5		2.86	2.42	2.24	2.06	1.94	1.90
-1	5		2.42	2.08	1.92	1.77	1.67	1.65
0	5		1.92	1.68	1.57	1.45	1.39	1.35
-20	6		4.05	3.63	3.42	3.23	3.14	3.09

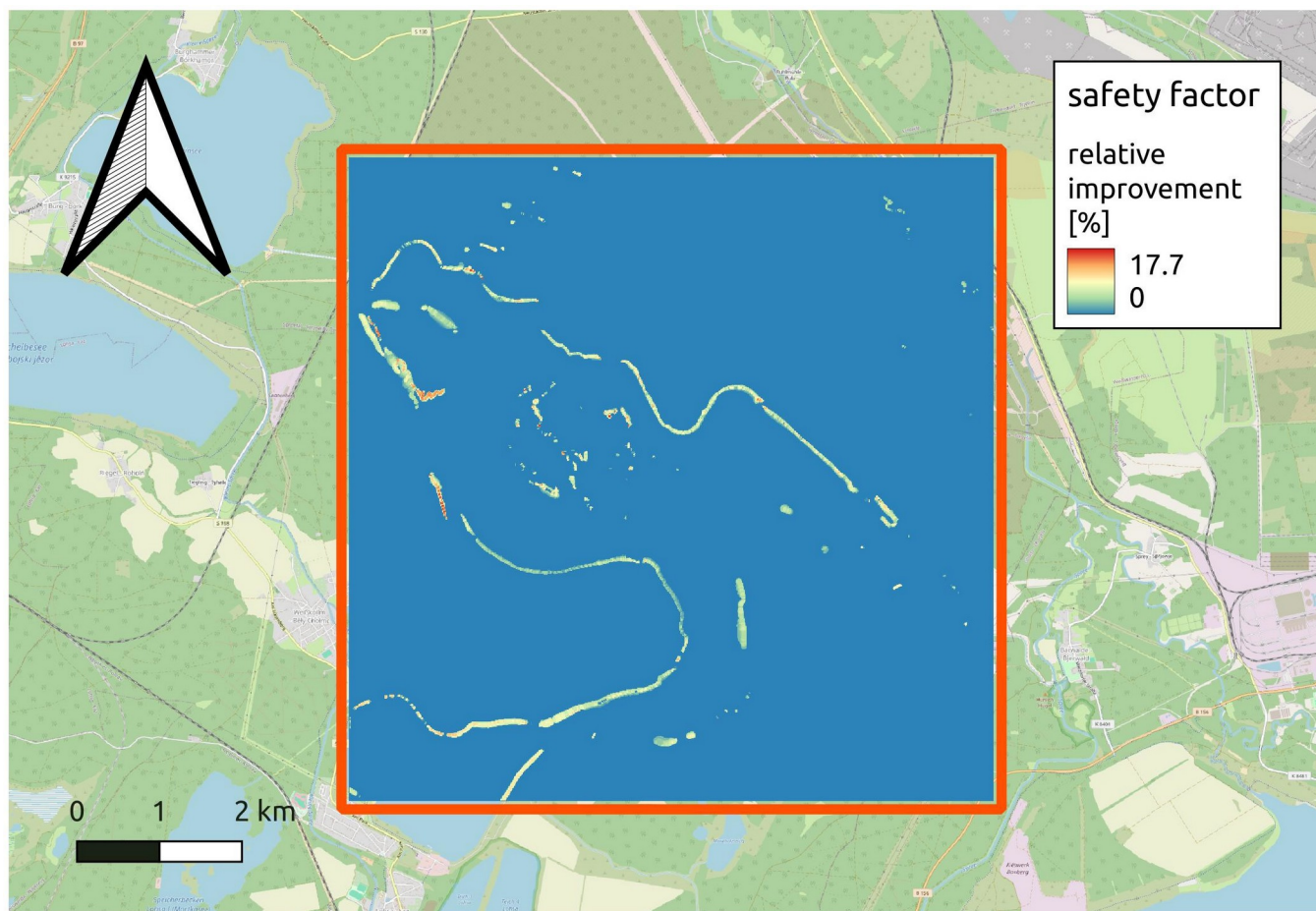
Výsledky

Ergebnisse

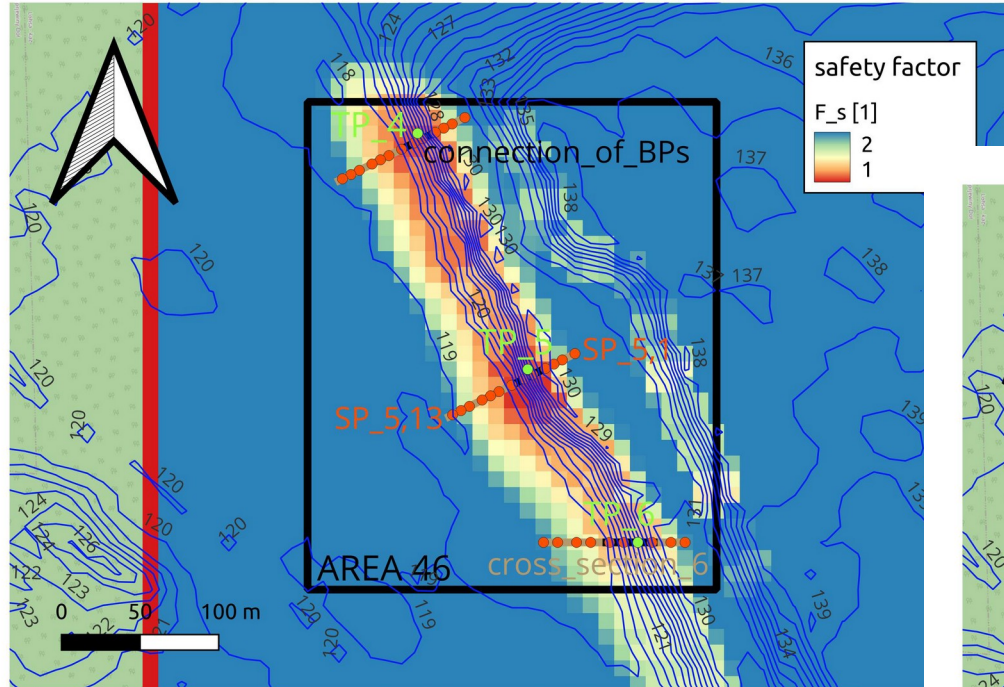


Nárůst stability

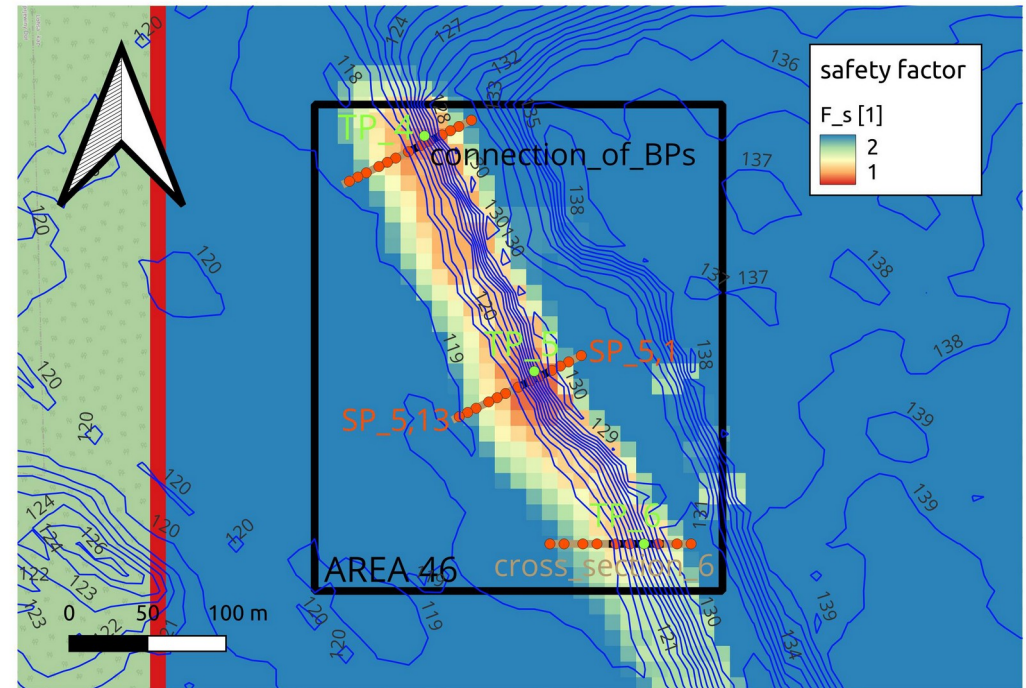
Verbesserung der Stabilität



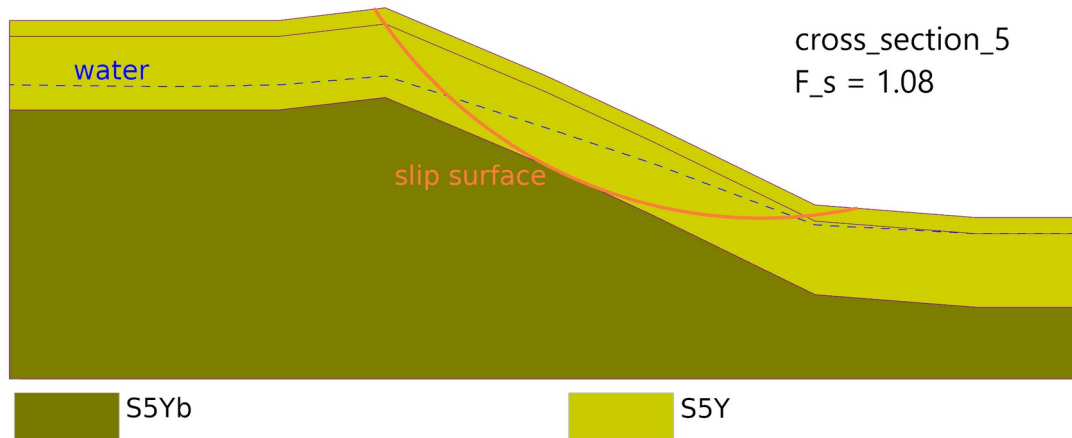
Nárůst stability



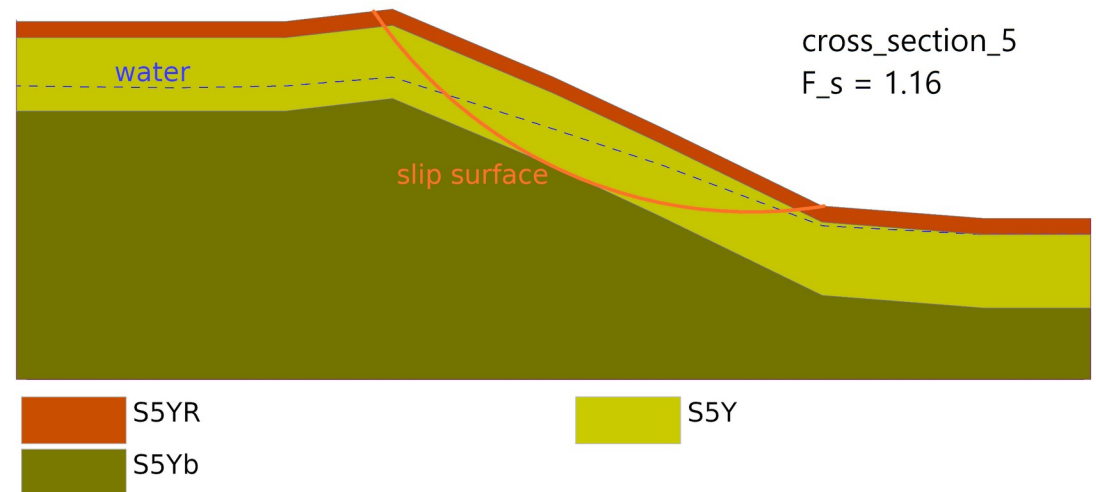
Verbesserung der Stabilität



Nárůst stability



Verbesserung der Stabilität



Zdroj

Literaturverzeichnis

ZEDEK, L.; ŠEMBERA, J.; KURKA, J. *Inclusion of Nature-Based Solution in the Evaluation of Slope Stability in Large Areas*. Land 2024, 13, 372. <https://doi.org/10.3390/land13030372>

Děkuji Vám za pozornost!

Vielen Dank für Ihre Aufmerksamkeit!