ANALYSIS OF THE IMPACT OF THE SOIL EROSION MODEL PARAMETERS ON EROSION INTENSITY AND SEDIMENT WEIGHT

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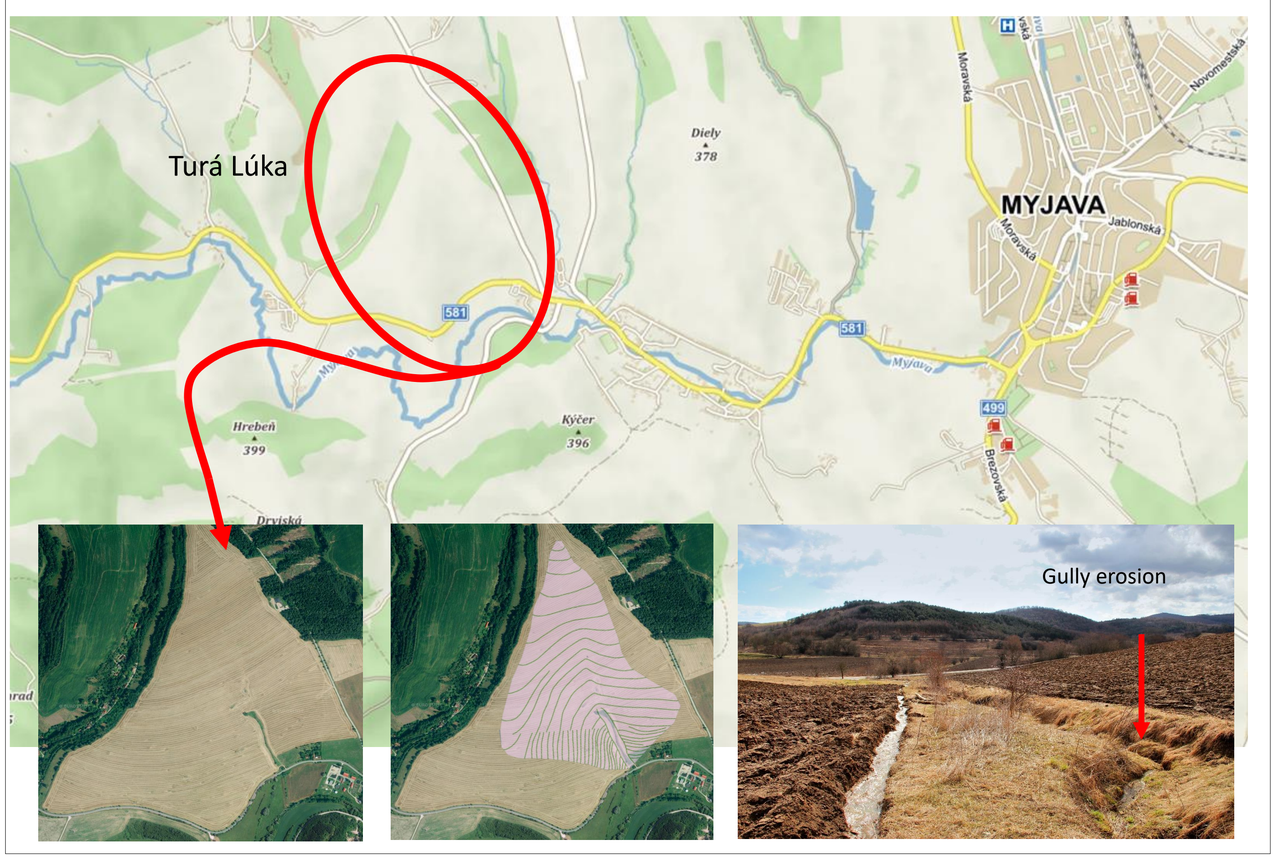
ABSTRACT

The aim of the study presented lies in an analysis of input parameters into a physically-based soil erosion model (EROSION-2D model). It is known that the input factors directly influence the model's results of evaluating soil erosion processes. In this case, the specific parameters of the soil erosion model, i.e., the skin factor, erosion resistance, and hydraulic roughness, were calibrated (set up) by comparing the modelled volumes of the soil sediment with the measured data on the experimental plots. Parameters of the model were also compared with the values in the literature (set parameters).

The results identify changes in the model parameters and their impact on the final simulated results in dependence on different initial conditions. The skin factor has the most significant influence on the outputs of the EROSION-2D model.

1 STUDY AREA

The study area on the Turá Lúka hilly agricultural field has an area of 0.29 km^2 and is mainly represented by slopes with arable land and an erosion gully with seven small wooden check dams inbuilt to stabilise the gully.



2 METHODS

In this study, we will focus on the possibility of the parameterization of the Erosion-2D model. The Erosion-2D model describes the erosion processes in a complex way and is therefore constructed based on the following components:

1. The digital elevation model, which includes interpolation of a 1 m grid from the input data, calculation of the topographic parameters from the slope profile, calculation of the individual catchment area and length of the flow path for each cell (runoff concentration),
2. The Infiltration model which includes rainfall infiltration (Green-Ampt approach)
3. The runoff and erosion sub model performs the simulation calculations

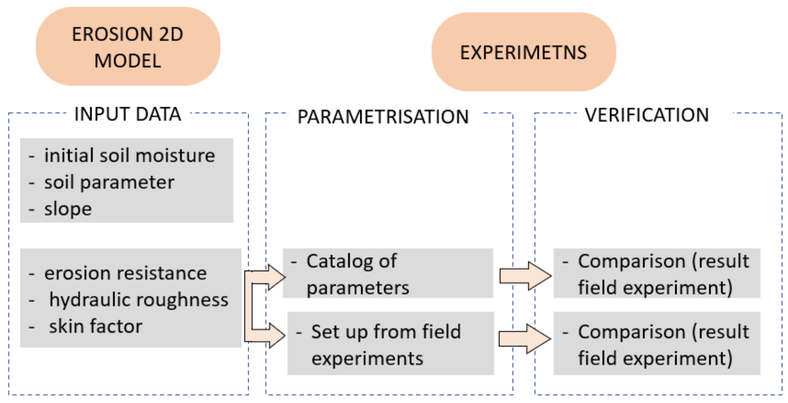


Fig. 2 Conceptual scheme of the methodology

Tab. 1 Parameters of the EROSION-2D model according to the catalog of parameters, for the soil type located in the studied area

Bulk density [kg/m^3]	Organic matter [%]	Erosion resistance [kg.m.s^{-2}]	Manning roughness [s.m$^{-1/3}$]	Canopy cover [%]	Skin factor [-]	Clay [%]	Silt [%]	Sand [%]
1800	1,15	0,0008	0,015	0	1	10	36	48

3 RESULTS

Tab. 2 Summary of precipitation simulations in EROSION-2D (calculated on an area of 1m^2), A) – catalog parameter, B) set up Manning roughness C) set up Erosion resistance D) set up Skin factor E) set up all parameters together

Experiment No.	Scheme	Initial soil moisture [%]	Erosion resistance [kg.m.s^{-2}]	Manning roughness [s.m-1/3]	Skin factor [-]	Sediment Volume [kg/m]	Terrain - sediment Volume [kg/m]
1	A)	37,4	0,0008	0,015	1	0,8809	0,0240
	B)	37,4	0,0008	6,5	1	0.0238	
	C)	37,4	0,028	0,015	1	0,0239	
	D)	37,4	0,0008	0,015	25,5	0,0243	
	E)	37,4	0,0055	0,25	0,9	0,0243	
2	A)	38,6	0,0008	0,015	1	0,9291	0,0142
	B)	38,6	0,0008	10	1	0,0194	
	C)	38,6	0,053	0,015	1	0,0143	
	D)	38,6	0,0008	0,015	30,09	0,0143	
	E)	38,6	0,00695	0,45	0,9	0,0143	
3	A)	25,9	0,0008	0,015	1	1,4064	0,5800
	B)	25,9	0,0008	0,068	1	0,5715	
	C)	25,9	0,00198	0,015	1	0,5685	
	D)	25,9	0,0008	0,015	7,1	0,5690	
	E)	25,9	0,00065	0,1	0,9	0,5733	
4	A)	20,5	0,0008	0,015	1	0,9214	0,3933
	B)	20,5	0,0008	0,06	1	0,4034	
	C)	20,5	0,00182	0,015	1	0,4051	
	D)	20,5	0,0008	0,015	2,65	0,4021	
	E)	20,5	0,001	0,045	0,9	0,3990	

* Bulk density 1800 [kg/m^3], organic matter 1,15 [%], cover 0 ~ 80 [%]

Verification process:

- Setup group 1 (rainfalls 1,2) – erosion resistance 0,0062 [kg.m.s-2], roughness 0,4 [s.m$^{-1/3}$], cover 55 [%], skin factor 0,9 [-]
- Setup group 2 (rainfalls 3,4) – erosion resistance 0,001 [kg.m.s^{-2}], roughness 0,073 [s.m$^{-1/3}$], cover 8 [%], Skin factor 0,9 [-]

Tab. 3 Experiments: 4 artificial precipitation

Exp. No.	Intenzity [mm/min]	Duration [min]
1	3.2	10
2	3.2	10
3	5.1	12 (4x3)
4	5.0	12 (4x3)

Experiment No. 1 and 2: duration of the artificial precipitation 10 minutes (without interruption).
Experiment No. 3 and 4: artificial precipitation lasting 12 minutes (4 separate precipitation)

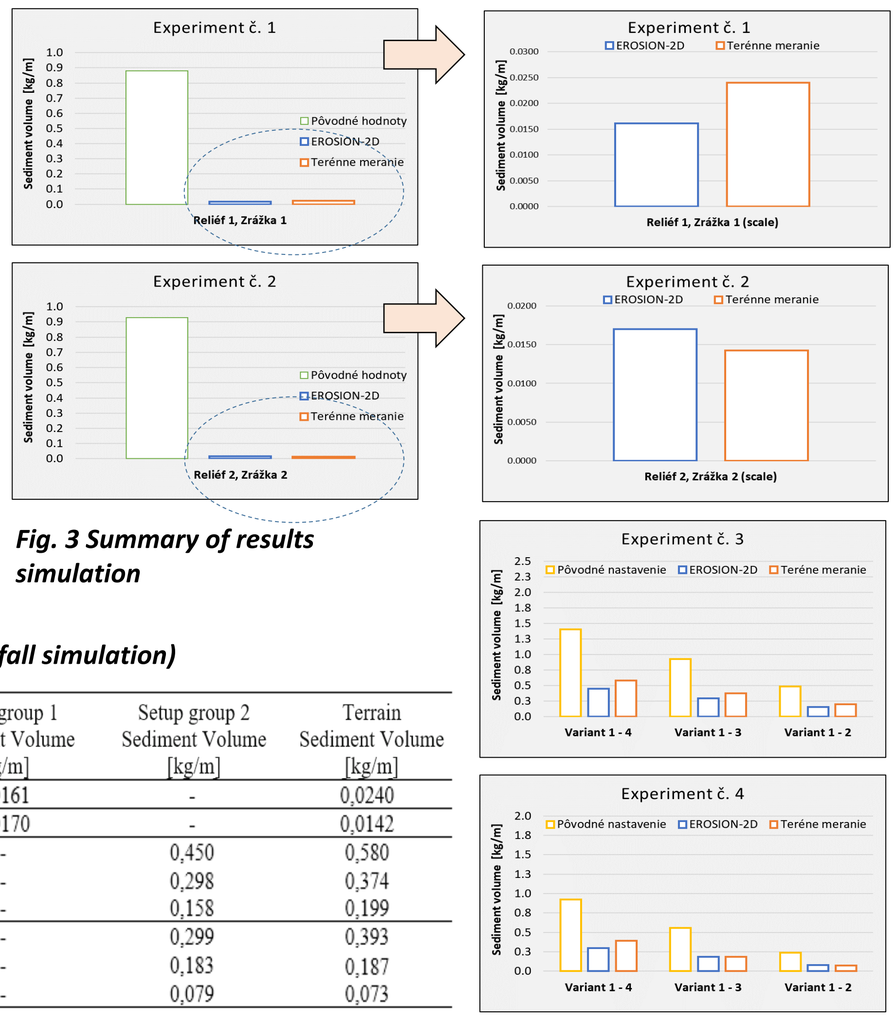


Fig. 3 Summary of results simulation

Tab. 4 Verification (summary from the rainfall simulation)

Exp. No.	Variant (single rainfall)	Total time [min]	Initial soil moisture [%]	Setup group 1 Sediment Volume [kg/m]	Setup group 2 Sediment Volume [kg/m]	Terrain Sediment Volume [kg/m]
1	1	10	37,4	0,0161	-	0,0240
2	1	10	38,6	0,0170	-	0,0142
3	1 - 4	12	25,9	-	0,450	0,580
	1 - 3	9	25,9	-	0,298	0,374
	1 - 2	6	25,9	-	0,158	0,199
4	1 - 4	12	13,2	-	0,299	0,393
	1 - 3	9	13,2	-	0,183	0,187
	1 - 2	6	13,2	-	0,079	0,073

4 CONCLUSION

The parametrization and validations of erosion models represents a necessary and significant part of any scientific work. In this study, the parameters of the EROSION-2D/3D model, i.e., erosion resistance, the skin factor and hydraulic roughness, were adjusted (set up) by comparing the modelled volumes of the soil sediment with the measured data on the experimental plots. The results from the field experiments show that outputs from the rainfall simulations can be reproduced successfully and that based on those outputs, the process of determining a model´s parameters can be successfully performed. The disadvantage is seen in the area of the small simulator. The experimental results of the small-scale simulator are susceptible to measurement and model errors. It is necessary to work with a larger number of measurements and analyse the results. In conclusion, it is possible to state that the model overestimates the amount of sediment on higher slopes, which can be modified by a higher degree of roughness.

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