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Evaluation of methods for determining the LS index at different resolutions for soil erosion modeling using the RUSLE method

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Abstract. This paper investigates the impact of Digital Terrain Model (DTM) resolution on the calculation of the sediment transport capacity coefficient LS within the Bystra catchment, employing various methods through GIS software. The study focuses on the significant role of GIS in environmental research and process modeling, emphasizing the relevance of LS coefficient analysis in morphometry, hydrology, and geomorphology, particularly in the context of agricultural soil erosion.

The study presents results from calculating the sediment transport capacity factor LS using three methods for different resolutions (1, 5, 10, 30, 90 meters). LS coefficient determination relies on the catchment area map and slope map, the latter determined using two methods. The catchment area considered is that of the Bystra River, a right tributary of the Vistula, flowing through Nałęczów, Wąwolnica, Celejów, Bochotnica in the Lublin Province.

Upon determining the LS coefficient, variations in results are observed, dependent on the chosen method. The discussion section highlights differences in LS coefficient maps based on resolution and method, with notable distinctions in the north-western part for a 10-meter resolution.

Analyzing LS coefficient maps at different resolutions, the study observes variations in results based on the method employed. Higher LS coefficient values are noted in the river channel for a 1-meter resolution, attributed to factors such as river bed structure, building rocks, terrain slope, and climate.

The conclusions emphasize the use of specific methods for determining slope rasters and highlight the Desmet and Govers method as yielding smaller variances in LS coefficient determination compared to other methods. The study recommends DTM models with resolutions of 1, 5, and 10 meters for LS modeling, considering their beneficial influence on variance and resolution.

In summary, this paper contributes valuable insights into the influence of DTM resolution on LS coefficient calculations, providing a nuanced understanding of the interplay between methods, resolution, and terrain characteristics in the context of sediment transport capacity.

Keywords: LS factor, soil erosion, spatial resolution

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INTRODUCTION

One of the significant negative factors affecting the agricultural landscape is soil erosion (Wawer, Nowocień, 2018). Soil erosion is the process of losing the top layer of soil due to the destructive action of wind, water, or other natural factors, initiated or exacerbated by human activity. Soil erosion poses a serious challenge to agriculture and the environment, leading to soil degradation, reduced fertility, and loss of biodiversity (Józefaciuk, Józefaciuk, 1996). In Poland, surface water erosion and gully erosion are particularly threatening, generating a range of adverse effects on both the natural environment and the economy (Józefaciuk et al., 2014; Nowocień, 2008; Wawer, Nowocień, 2018).

Furthermore, studies conducted in the 1980s identified water erosion as one of the main causes of the decline in agricultural soil productivity worldwide (Niedźwiecki et al., 2020). Numerous publications focus on anti-erosion strategies and actions aimed at counteracting this soil degradation process (Józefaciuk et al., 2002; Podolski, 2008; Woch, 2008).

Quantitative assessment of soil erosion can be modeled using the Universal Soil Loss Equation (USLE) and its revised version, the Revised Universal Soil Loss Equation (RUSLE) (Renard et al., 1997). Models based on RUSLE are by far the most commonly applied globally for predicting soil erosion (Borrelli et al., 2021).

The primary input layers of the USLE model include average annual erosivity of rainfall and runoff (factor R), susceptibility of soils to erosion (factor K), dimensionless factor of crop type and land use (factor C), dimensionless slope length factor and dimensionless slope coefficient (factors LS), dimensionless coefficient of erosion control treatments (factor P). It is noteworthy that factors LS and C exert the most significant influence on the modeling of soil loss (Panagos et al., 2015).

This article focuses on assessing methods for determining the LS factor based on DTMs at various resolutions for soil erosion modeling using the RUSLE method, employing GIS software (Geographical Information System), within the watershed of the Bystra River. GIS is widely used in the study of the natural environment and the modelling of processes occurring in it. One of the basic processes of DTM processing is the calculation of the sediment transport capacity coefficient LS. This parameter, which shows the relief of the land surface, is an important factor in morphometric studies, hydrology and geomorphology. The analysis of the sediment transport capacity coefficient LS is an important factor in the context of soil erosion in agriculture.

The results of calculating the sediment transport capacity factor LS using three different methods of determining the LS factor: Moore (Moore et al., 1991), Desmet and Govers (Desmet, Govers, 1996a), Boehner and Selige (Boehner, Selige, 2006). These methods were applied for specific resolutions of 1, 5, 10, 30, and 90 meters. The sediment transport coefficient LS was determined based on the area map of the recharge area – catchment area – and the slope map, which for the purposes of the article was determined using two methods: the 6 parameter 2nd order polynom method (Bauer et al., 1985; Badora, Wawer, 2022) and the 9 parameter 2nd order polynom (Zevenbergen, Thorne, 1987; Badora, Wawer, 2022).

STUDY AREA

The watershed of the Bystra River constitutes a right tributary to the Vistula River. It is located in the Lublin Voivodeship, Poland (Figure 1). The Bystra River flows through various localities, including Nałęczów, Wąwolnica, Celejów, and Bochotnica. The river has a length of 33 km, covering an catchment area of 306.9 km^2 (MPHP, 2017). The watershed traverses two subregions in the northwestern part of the Lublin Upland (Chałubińska, Wilgat, 1954). The lowest point in the watershed is situated at an elevation of 124 m above sea level, while the highest point reaches 247 m above sea level. The valley of the Bystra River and

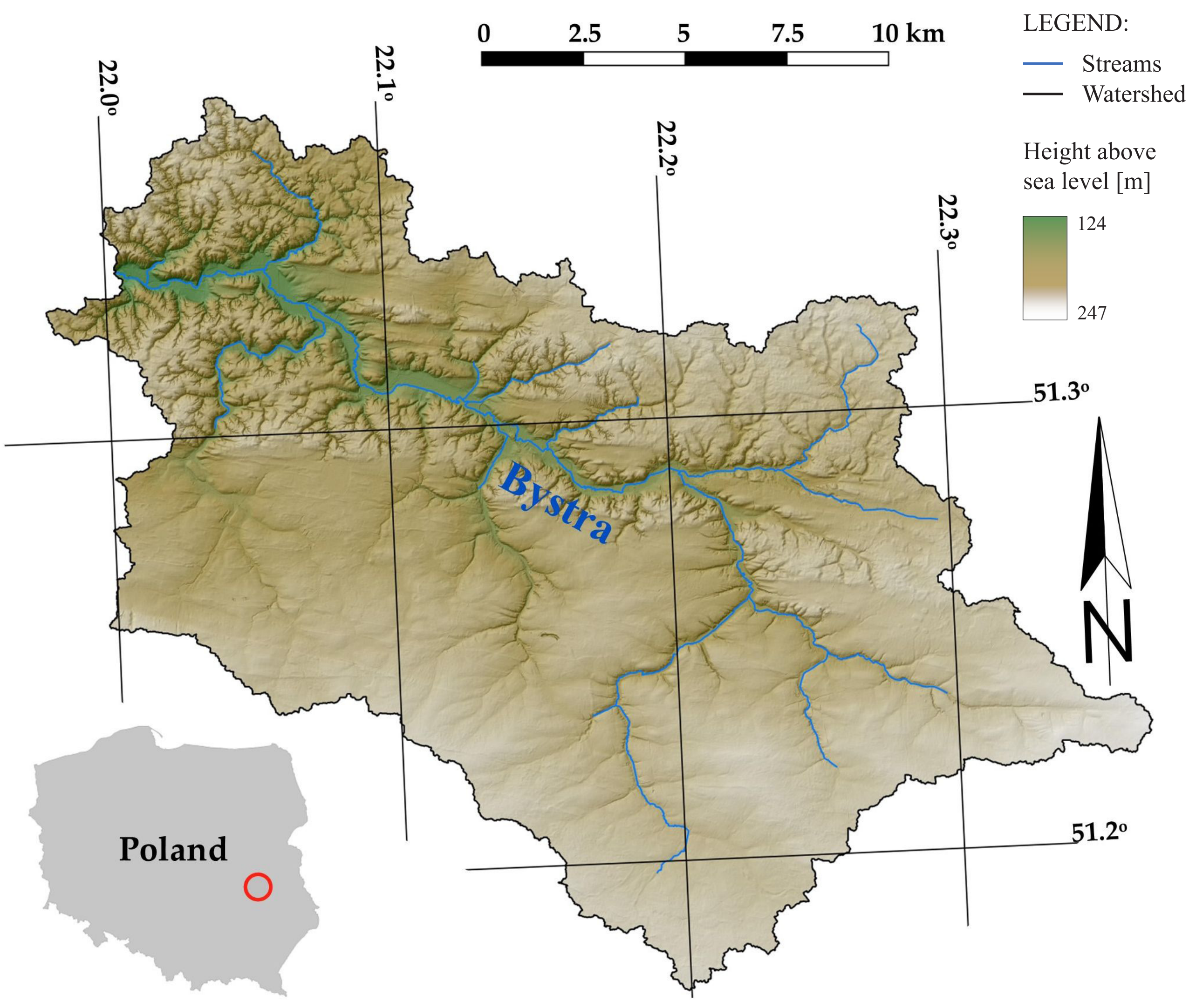


Figure 1. The watershed area of the Bystra River (authors' own study).

its tributaries exhibit significant topography, with a notable risk of erosion due to the upland nature of the watershed, characterized by the prevalence of loess soils and steep slopes, particularly at the confluence of the Bystra River with the Vistula (Jurga et al., 2018).

METHODS

Methods of determining the LS factor

The sediment transport capacity index (*LS*) corresponds to the topographic product *LS* in the empirical soil erosion model Universal Soil Loss Equation – USLE (Urbański, 2012). The USLE model is a soil loss equation developed by Wischmeier and Smith in 1978 (Wischmeier, Smith, 1978) in the USA (Kowalczyk, Twardy, 2012). A later development of the above method is the Revised Universal Soil Loss Equation – RUSLE model (Renard et al., 1997) developed in the 1990s (Mularz, Drzewiecki, 2007).

The universal equation for soil loss due to erosion is estimated using the expression:

$$E = R\,K\,L\,S\,C\,P$$

where:
E – multi-year average annual mass of eroded soil per unit area [Mg km^{-2} year^{-1}];
R – average annual erosivity of rainfall and runoff [Je year^{-1}]; (Je – unit of eroded soil [MJ ha^{-1} cm h^{-1}]);
K – susceptibility of soils to erosion [Mg km^{-2} Je^{-1}];
L – dimensionless slope length factor;
S – dimensionless slope coefficient;
C – dimensionless factor of crop type and land use;
P – dimensionless coefficient of erosion control treatments (Kowalczyk, Twardy, 2012).

The dimensionless slope length factor (*L*) and the dimensionless slope factor (*S*) combine to form a single *LS factor*. This can be calculated from the following formula (Foster, Wischmeier, 1974):

$$LS = \sum_{j=1}^{N} \frac{S_j \lambda_j^{m+1} - S_j \lambda_{j-1}^{m+1}}{(\lambda_j - \lambda_{j-1})(22.13)^m}$$

where:
S_j – slope index for the jth field segment,
λ_j – distance from the lower boundary of the jth field segment to the upper boundary of the field,
m – exponent of the slope length index (Mularz, Drzewiecki, 2007).

The slope index for the jth field segment can be calculated from the following formula (Wischmeier, Smith, 1978):

$$S = 65.41\sin^2\theta + 4.56\sin\theta + 0.065$$

where:
θ – the angle of slope (Wischmeier, Smith, 1978; Mularz, Drzewiecki, 2007)

The index m has a different value depending on the method used to calculate the slope index S. For the above equation, m=0.5 for $\mathrm{tg}\ \theta>0.05$, m=0.4 for $0.03<\mathrm{tg}\ \theta\leq0.05$, m=0.3 for $0.01<\mathrm{tg}\ \theta\leq0.03$, and m=0.2 for $\mathrm{tg}\ \theta\leq0.01$ (Moore, Wilson, 1992).

For the RUSLE model, formulas are used:

$S = 10.8\sin\theta + 0.03$ for $\mathrm{tg}\ \theta<0.09$
$S = 16.8\sin\theta - 0.5$ for $\mathrm{tg}\ \theta\geq0.09$ (Moore, Wilson, 1992; Renard et al., 1997)

In contrast, the m-index for the RUSLE model is calculated from the formula (McCool et al., 1989; Renard et al., 1997):

$$m = \frac{\beta}{\beta+1}$$

where:

$$\beta = \frac{sin\theta/0.0896}{3(sin\theta)^{0.8} + 0.56}$$

For the study area where inter-groove erosion is prevalent, the β value is multiplied by 0.5, while when gully erosion is present, the β value is multiplied by 2 (Mularz, Drzewiecki, 2007).

A number of authors including Moore and Burch (Moore, Burch, 1986a, 1986b), Moore and Wilson (Moore, Wilson, 1992), Desmet and Govers (Desmet, Govers, 1996a, 1996b, 1997), Mitasova et al. (Mitasova et al., 1996, 1998) showed that the effect of relief on the behavior of water that flows over its surface is better reproduced when the slope length in the *LS* coefficient is replaced by the runoff area, or more precisely by a quantity that is the quotient of the area of the recharge area and the length of a given slope section (Mularz, Drzewiecki 2007).

In 1996, Desmet and Govers (Desmet, Govers, 1996a) substituted slope length for unit area of runoff:

$$L_{(i,j)} = \frac{(A_{(i,j)} + D^2)^{m+1} - A_{(i,j)}^{m+1}}{x^m \cdot D^{m+2} \cdot (22.13)^m}$$

where:
D – raster resolution,
$A_{(i,j)}$ – unit area of supply at the entrance to the cell (*i,j*),
m – exponent of the slope length index,
x – correction factor for the length of the flow path through the raster pixel, dependent on the direction of the runoff and calculated from the exposure.

By replacing the length of the slope with the size of the unit area of the recharge area, it is possible to better model the effect of the relief on the behaviour of the water that flows over its surface. If the slope elements are represented by raster pixels, the unit area of the recharge area for a given pixel can be obtained by dividing the area of its recharge area by the distance the flowing water travels as it moves within that pixel (Mularz, Drzewiecki, 2007).

Replacing the length of the slope by the unit area of runoff provides the opportunity to include the effect of runoff water concentration in the model (Mitasova et al., 1999).

In 2006, Boehner and Selige also proposed a formula for calculating the sediment transport index (STI):

$$STI_S = \left(\frac{CA^{0.5}}{22.13}\right)^{0.5} (65.14\sin^2\beta_{CA} + 4.56\sin\beta_{CA} + 0.065)\ for\ \beta_{CA} > 0.0505$$

$$STI_S = \left(\frac{CA^{0.5}}{22.13}\right)^{3\cdot{\beta_{CA}}^{0.6}} (65.14\sin^2\beta_{CA} + 4.56\sin\beta_{CA} + 0.065)$$

where:

$$\beta_{CA} = \frac{\sum_{i=1}^{n} \beta_i CA_i^{0.5}}{\sum_{i=1}^{n} CA_i^{0.5}}$$ – weighted average angle of slope of the feed area,

CA – catchment area (Boehner, Selige, 2006).

Determination of the LS factor

The datasets used in this publication are from the Central Geodetic and Cartographic Documentation Centre. The data are divided into sheets according to the headings for the 1992 system (EPSG:2180) with a field pixel size of 0.5 m and a scale of 1:5000 (CODGiK, 2013).

Quantum GIS 2.18.5 (QGIS, 2005) and SAGA GIS 4.0.1 (SAGA GIS, 2004) software were used to process the data. The datasets were loaded into SAGA GIS as separate rasters representing individual DTM sheets and combined using the Mosaicking process. Different raster resolutions were then created for the unified raster using the Resampling process for pixel sizes of 1, 5, 10, 30, 90 meters. In the next step, for the different resolutions of 1, 5, 10, 30 and 90 meters, the catchment boundary of the Bystra River was determined using the Basic Terrain Analysis process where drainage basic and the river channel network created.

Then, for specific resolutions of 1, 5, 10, 30 and 90 meters, rasters with slopes were created for 2 slope calculation methods in the SAGA GIS software: 6 parameter 2nd order polynom (Bauer et al., 1985) and 9 parameter 2nd order polynom (Zevenbergen, Thorne, 1987) using the Slope, Aspect, Curvature process (Badora, Wawer, 2022). The unit of slopes for the resulting rasters is radians. In the next step, using the Extended neighbourhoods – catchment areas (parallel) process, selecting the Deterministic 8 (O'Callaghan, Mark, 1984) catchment area calculation algorithm, rasters with catchment area (Drzewiecki, Ziętara, 2013) called catchment area were created for resolutions of 1, 5, 10, 30 and 90 metres. A catchment area is the area from which rainfall flows into a river, lake or reservoir. Drzewiecki and Ziętara (2013) investigated the impact of the choice of surface runoff path generation algorithm on the results of estimating the current erosion hazard of soils.

The prepared rasters for slopes and catchment area were used to create LS coefficient rasters for the three methods: Moore et al. (Moore et al., 1991), Desmet and Govers (Desmet, Govers, 1996a), Boehner and Selige (Boehner, Selige, 2006).

RESULTS

After receiving the finished LS coefficient rasters, the following LS coefficient statistics were generated for each raster (for the two slope calculation methods) using the Save Grid Statistic to Table process: number of pixels in the raster (Number of Data Cells), pixel size (Cellsize), arithmetic mean (Arithmetic Mean), minimum value (minimum), maximum value (maximum), range of values (Range), variance (Variance), standard deviation (Standard Deviation) (Table 1, Table 2).

From the analysis of the tables (Table 1, Table 2), it can be seen that the smallest differences between the arithmetic means for all resolutions occur with the Desmet and Govers method (Desmet, Govers, 1996a) for both the method of calculating the slopes of the 6 parameter 2nd order polynom (Bauer et al., 1985) as well as the 9 parameter 2nd order polynom (Zevenbergen, Thorne, 1987). The largest changes in ranges occur with the Boehner and Selige method (Boehner, Selige, 2006), while the smallest changes occur with the Desmet and Govers method (Desmet, Govers, 1996a).

In the next step, the variances for the three methods of determining the LS coefficient were compared for resolutions of 1, 5, 10, 30 and 90 meters using a raster of slopes calculated using the 9 parameter 2nd order polynom method (Zevenbergen, Thorne, 1987) (Figure 2) and the 6 parameter 2nd order polynom method (Bauer et al., 1985) (Figure 3).

From the analysis of the graphs (Fig. 2, Fig. 3), it can be seen that the smallest variance change as a function of resolution occurs for the Desmet and Govers method (Desmet, Govers, 1996a) using the raster of slopes from the 6 parameter 2nd order polynom method (Bauer et al., 1985). In contrast, the

Table 1. Statistics for LS Factor estimates for various spatial resolutions – 9 parameter 2nd order polynom method (authors' own study).

Methods name	Number of data cells	Cellsize	Arithmetic mean	Minimum	Maximum	Range	Variance	Standard deviation
Moore et al., 1991	309816175	1	0.63	0.00	47.06	47.06	1.84	1.36
Desmet, Govers, 1996a	309816175	1	0.57	0.03	74.38	74.35	0.93	0.96
Boehner, Selige 2006	309816175	1	0.58	0.06	111.03	110.97	2.97	1.72
Moore et al., 1991	12392647	5	0.93	0.00	38.60	38.60	3.75	1.94
Desmet, Govers, 1996a	12392647	5	0.61	0.03	27.15	27.12	0.88	0.94
Boehner, Selige, 2006	12392647	5	0.92	0.06	75.98	75.92	6.37	2.52
Moore et al., 1991	3101700	10	1.05	0.00	38.37	38.37	4.20	2.05
Desmet, Govers, 1996a	3101700	10	0.68	0.03	18.39	18.36	1.03	1.02
Boehner, Selige, 2006	3101700	10	1.03	0.06	73.91	73.84	6.70	2.59
More et al., 1991	326778	30	1.20	0.00	30.03	30.03	4.07	2.02
Desmet, Govers, 1996a	326778	30	0.86	0.03	12.73	12.70	1.63	1.28
Boehner, Selige, 2006	326778	30	1.13	0.07	52.85	52.78	5.45	2.34
Moore et al., 1991	35770	90	1.10	0.00	19.24	19.24	2.50	1.58
Desmet, Govers, 1996a	35770	90	0.88	0.03	14.03	14.00	1.64	1.28
Boehner, Selige, 2006	35770	90	0.98	0.07	27.45	27.39	2.69	1.64

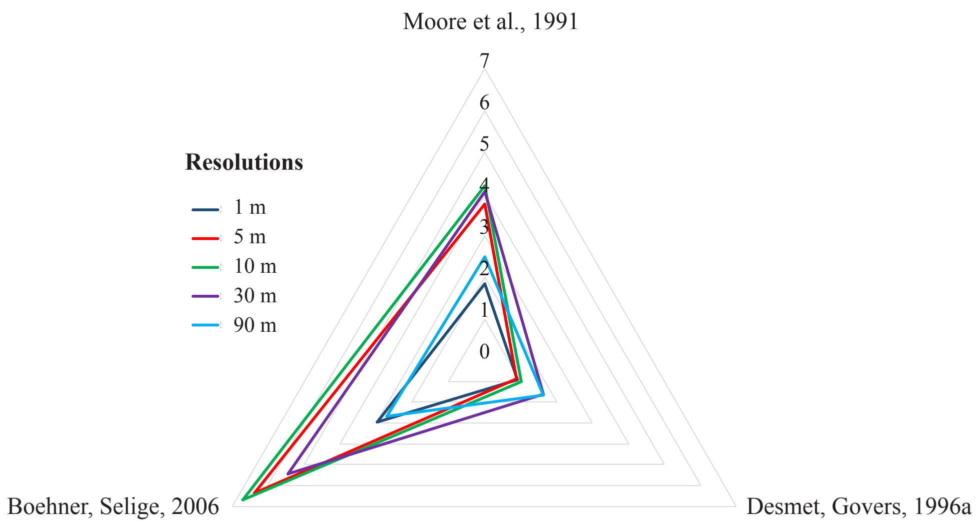
Table 2. Statistics for LS Factor estimates for various spatial resolutions – 6 parameter 2nd order polynom method (authors' own study).

Methods name	Number of data cells	Cellsize	Arithmetic mean	Minimum	Maximum	Range	Variance	Standard deviation
Moore et al., 1991	309816175	1	0.60	0.00	46.91	46.91	1.80	1.34
Desmet, Govers, 1996a	309816175	1	0.55	0.03	64.48	64.45	0.92	0.96
Boehner, Selige, 2006	309816175	1	0.57	0.06	110.48	110.42	2.85	1.69
Moore et al., 1991	12392647	5	0.89	0.00	34.88	34.88	3.30	1.82
Desmet, Govers, 1996a	12392647	5	0.59	0.03	24.65	24.62	0.80	0.89
Boehner, Selige, 2006	12392647	5	0.87	0.06	73.68	73.62	5.23	2.29
Moore et al., 1991	3101700	10	0.98	0.00	32.66	32.66	3.39	1.84
Desmet, Govers, 1996a	3101700	10	0.64	0.03	15.76	15.73	0.87	0.93
Boehner, Selige, 2006	3101700	10	0.93	0.06	61.53	61.47	4.84	2.20
Moore et al., 1991	326778	30	1.08	0.00	23.61	23.61	3.01	1.74
Desmet, Govers, 1996a	326778	30	0.78	0.03	11.77	11.74	1.24	1.11
Boehner, Selige, 2006	326778	30	0.98	0.07	39.49	39.42	3.62	1.90
Moore et al., 1991	35770	90	0.93	0.00	14.45	14.45	1.63	1.28
Desmet, Govers, 1996a	35770	90	0.74	0.03	12.53	12.50	1.02	1.01
Boehner, Selige, 2006	35770	90	0.80	0.07	19.15	19.09	1.58	1.26

largest changes in variance as a function of resolution occur for the Moore (Moore et al., 1991) and Boehner and Selige (Boehner, Selige, 2006) methods. The variance for a resolution of 90 metres is lower than the variance for a resolution of 30 metres for the Desmet and Govers method (Desmet, Govers 1996a) using the raster of slopes from the 6 parameter 2nd order polynom method (Bauer et al., 1985). In contrast, for the raster from the 9 parameter 2nd order polynom method (Zevenbergen, Thorne, 1987) the variances for the 90 and 30 meter resolutions are similar to each other.

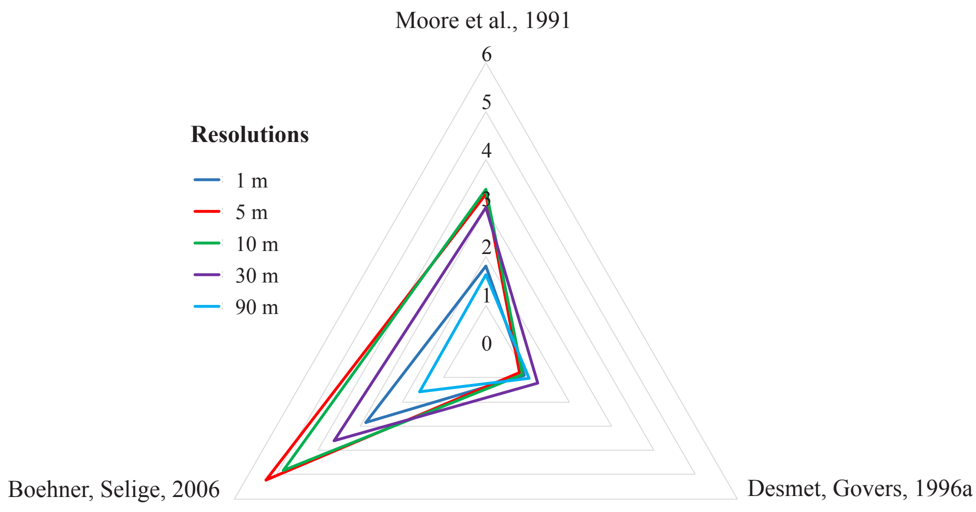
Maps were also compared for the three LS determination methods, for resolutions of 90 (Figure 4), 10 (Figure 5) and 1 meter (Figure 6), for which the slope raster created by the 6 parameter 2nd order polynom and 9 parameter 2nd order polynom methods were used.

The maps in terms of one of the two methods for determining the slopes indicate visible differences between the methods used to determine the LS coefficient. Analysing the LS coefficient maps for a resolution of 10 metres (Figure 5), the maps obtained using the Desmet and Govers method (Desmet, Govers, 1996a) show the highest LS coefficient values less clearly in the north-western part of the map compared to the maps obtained using the Moore (Moore et al., 1991) and Boehner and Selige methods (Boehner, Selige, 2006). A similar situation can be



Method	Variance				
	1 m	5 m	10 m	30 m	90 m
Moore et al., 1991	1.84	3.75	4.20	4.07	2.50
Desmet, Govers, 1996a	0.93	0.88	1.03	1.63	1.64
Boehner, Selige, 2006	2.97	6.37	6.70	5.45	2.69

Figure 2. Variance for the three methods of determining the LS coefficient for resolutions of 1, 5, 10, 30 and 90 metres using the raster of slopes from the 9 parameter 2nd order polynom method (authors' own study).



Method	Variance				
	1 m	5 m	10 m	30 m	90 m
Moore et al., 1991	1.80	3.30	3.39	3.01	1.63
Desmet, Govers, 1996a	0.92	0.80	0.87	1.24	1.02
Boehner, Selige, 2006	2.85	5.23	4.84	3.62	1.58

Figure 3. Variation for the three methods of determining the LS coefficient for resolutions of 1, 5, 10, 30 and 90 metres using the raster of slopes from the 6 parameter 2nd order polynom method (authors' own study).

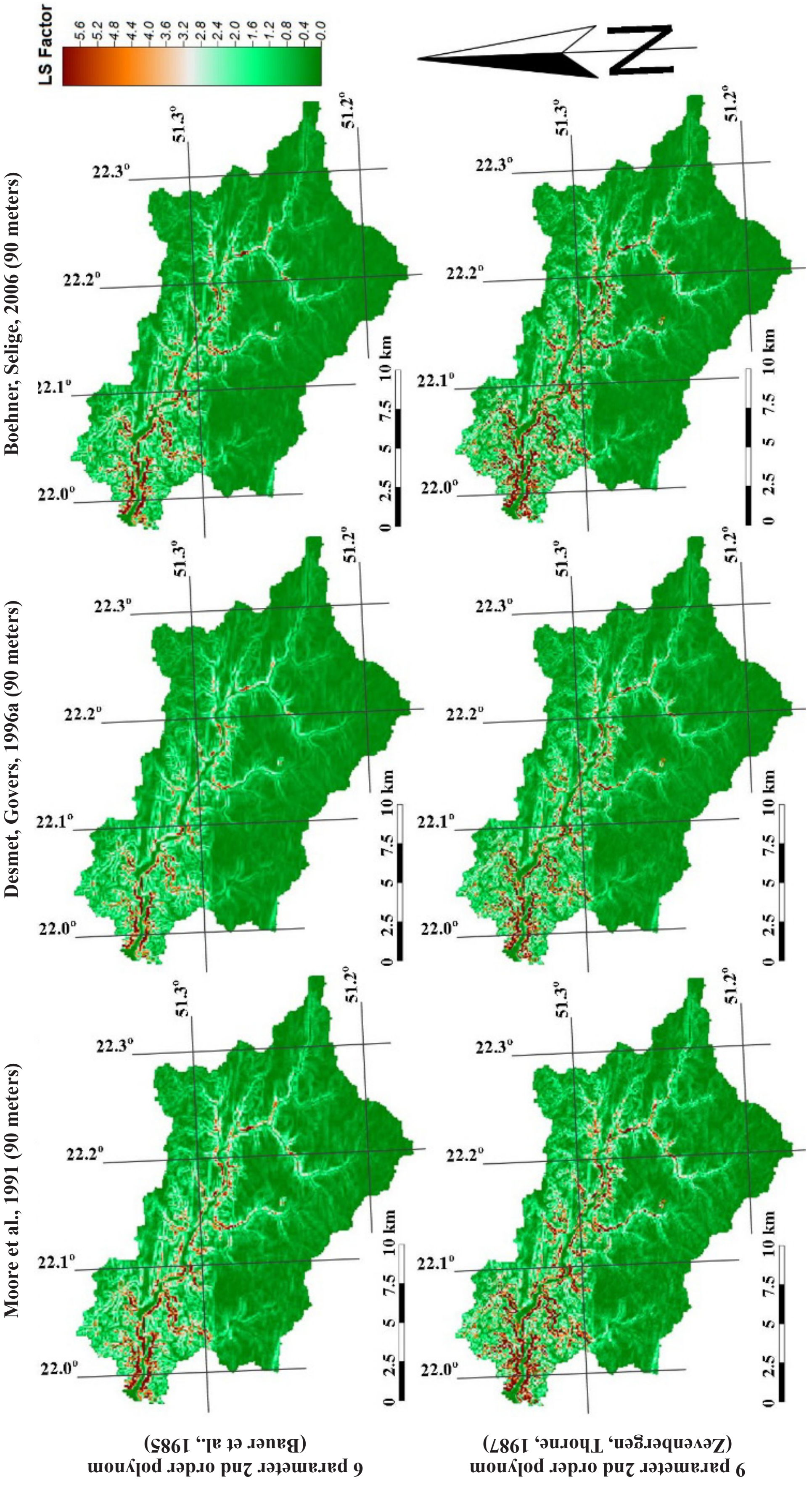


Figure 4. Maps for the three methods of determining the LS coefficient for a resolution of 90 meters using the raster of gradients from the 6 parameter 2nd order polynom method and the 9 parameter 2nd order polynom method (authors' own study).

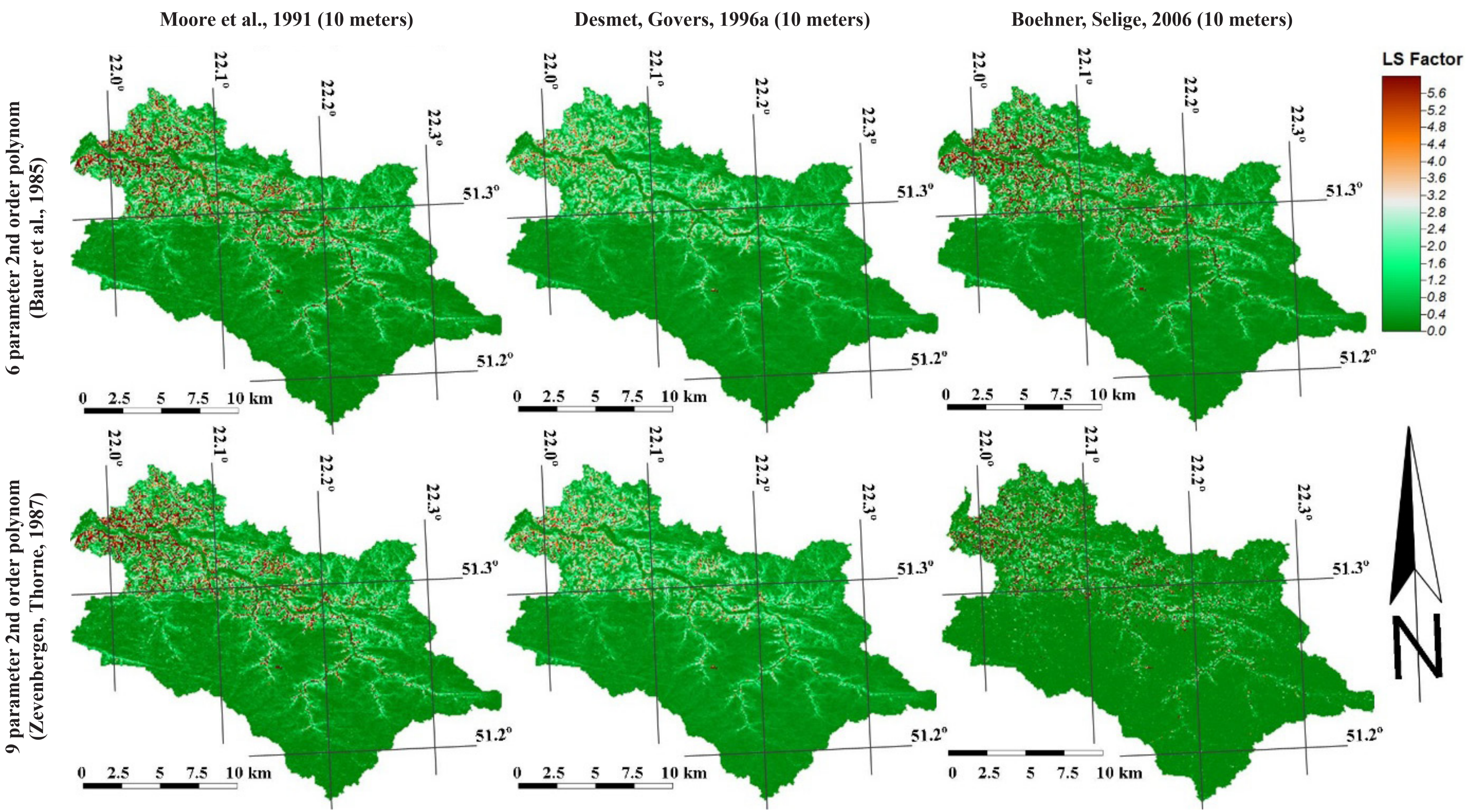


Figure 5. Maps for the three methods of determining the LS coefficient for a resolution of 10 meters using the raster of gradients from the 6 parameter 2nd order polynom method and the 9 parameter 2nd order polynom method (authors' own study).

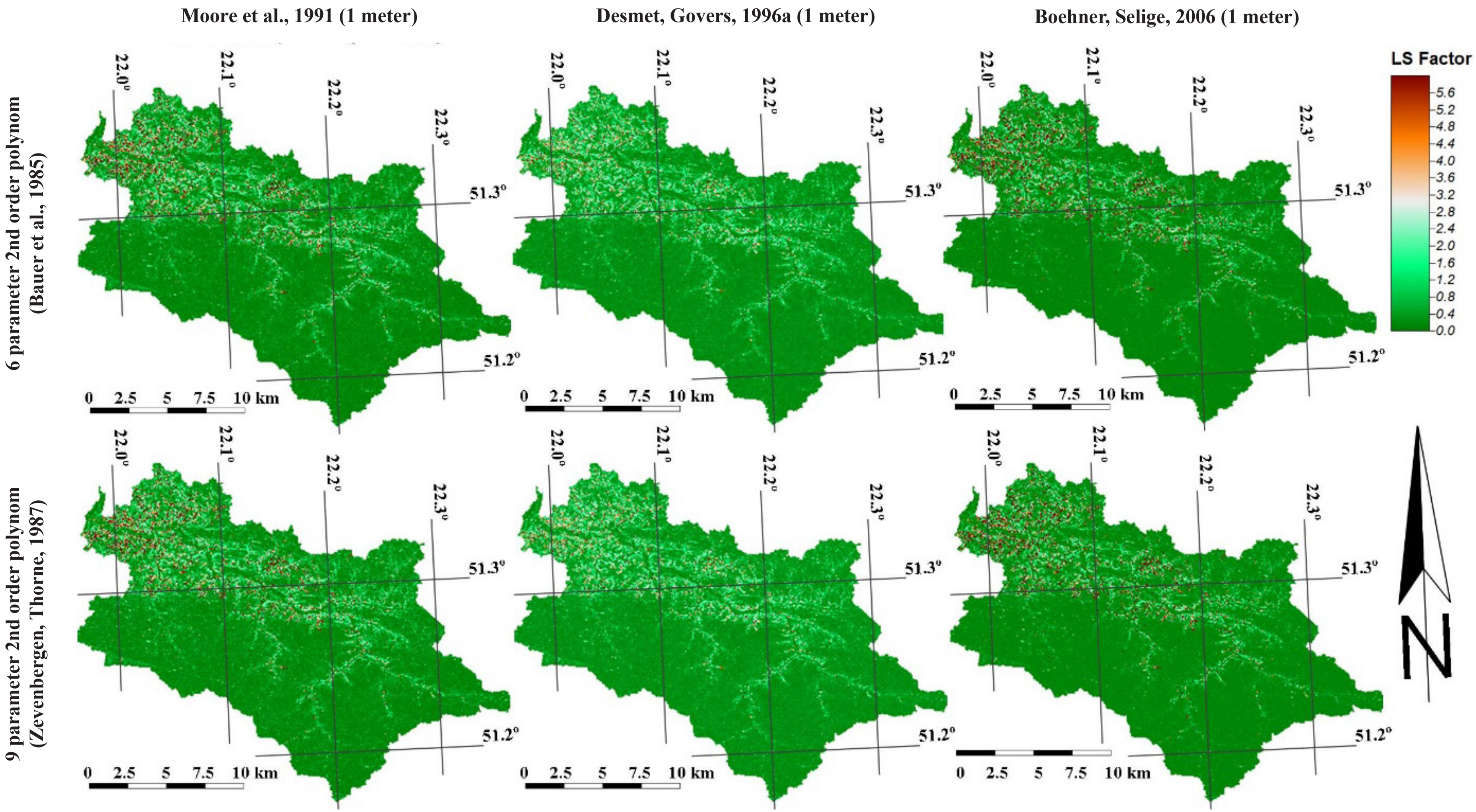


Figure 6. Maps for the three methods of determining the LS coefficient for 1 meter resolution using the raster of gradients from the 6 parameter 2nd order polynom method and the 9 parameter 2nd order polynom method (authors' own study).

Figure 7. Map of LS coefficient determination by Desmet and Govers method for 1 meter resolution using raster of slopes from 6 parameter 2nd order polynom method (authors' own study).

observed for LS factor maps with a resolution of 1 meter (Figure 7). The situation is different for maps with a resolution of 90 meters where the differences in the application of the different methods for determining the LS coefficient are hardly noticeable.

DISCUSSION

The publication emerged in 2015, describing a comprehensive study aimed at calculating the LS factor based on high-resolution DTM for the entire European Union (Panagos et al., 2015). The research employed the Desmet and Govers method (Desmet, Govers, 1996a). For the territory of Poland, the LS factor was determined as follows: arable land – 0.34, permanent crops – 0.30, pastures – 0.34, heterogen agriculture areas – 0.60, forests – 0.82, semi-natural areas – 0.82 and overall mean – 0.52. It is also worth mentioning that Poland (1.67), France (1.81), and Hungary (1.69) exhibit a high coefficient of variation compared to other European countries.

In this study concerning the Bystra River watershed, the LS factor for various calculation methods ranged from 0.55 to 0.63 at a resolution of 1 meter.

Using the example of the research area in Starovice – Hustopeče, located in the Czech Republic, two research methods were analyzed, differing in the complexity of calculations (Karásek et al., 2022). The aim of the study was to demonstrate that the choice of the LS factor determination method significantly impacts the overall assessment of the mean long-term soil loss using the USLE tool.

Calculations were conducted based on USLE 2D – variant 1A, 1B (Desmet, Govers, 1996a) and calculations based on the Mitášová equation – variant 2A, 2B (Mitášová et al., 1996). Variant 1A (LS factor – 2.78) and 1B (LS factor – 1.68) encompassed data from before 2009, while variant 2A (LS factor – 2.13) and 2B (LS factor – 1.40) involved data current during the publication creation. It was demonstrated that employing different methods for determining the LS factor can lead to permissible soil loss being achieved in both easier and more challenging ways. The report aimed to highlight the differences brought about by using these diverse LS factor assessment methods. Changes in LS factor calculations were directly reflected in the computations of the long-term average soil loss due to water erosion (Karásek et al., 2022).

For the territory of Slovakia, it has been demonstrated that 30.5% of its area has a potential for relief to erosion (LS factor) at the level of none or very low (slope steepness 0.0–2.0^{o} and S factor 0.07–0.40). 16.4% area has LS with level low (slope steepness 2.1–6.0^{o} and S factor 0.41–1.85), 14.1% area has LS with level moderate (slope steepness 6.1–10.0^{o} and S factor 1.86–4.29), 25.3% area has LS with level high (slope steepness 10.1–20.0^{o} and S factor 4.30–14.91) and 13.7% area has LS with level very high (slope steepness > 20.1^{o} and S factor >14.91) (Šúri et al., 2002).

In the article addressing the potential risk of soil erosion in the upper Parsęta River watershed, the LS factor is depicted on a map and ranges from 0.0 to 8.0. Additionally, based on the LS factor, four classes of susceptibility to erosion were identified within the intervals of 0–0.3, 0.3–1.1, 1.1–2.7, and >2.7 in the study (Szpikowski et al., 2018).

CONCLUSIONS

1. The sediment transport coefficient LS was determined based on a catchment area map and a slope map, which for the purpose of this paper was determined using two methods 6 parameter 2nd order polynom (Bauer et al., 1985) and 9 parameter 2nd order polynom (Zevenbergen, Thorne, 1987). An analysis of the effect of the determined slope rasters on the subsequent determination of the LS coefficient shows that the slope maps determined by the 6 parameter 2nd order polynom method (Bauer et al., 1985) yield smaller variances in the determination of the LS coefficient compared to the slope map determined by the 9 parameter 2nd order polynom method (Zevenbergen, Thorne, 1987).

2. In the following analysis, three methods were compared to determine the sediment transport coefficient of LS: Moore (Moore et al., 1991), Desmet and Govers (Desmet, Govers, 1996a), Boehner and Selige (Boehner, Selige, 2006), for specific resolutions of 1, 5, 10, 30 and 90 metres based on the slope map determined by the 6 parameter 2nd order polynom method (Bauer et al., 1985) and 9 parameter 2nd order polynom (Zevenbergen, Thorne, 1987). From the analysis of the statistical data (Table 1, Table 2) and the graphs (Figure 2, Figure 3), it can be seen that the smallest differences between the arithmetic means for all resolutions occur with the Desmet and Govers method (Desmet, Govers, 1996a). Also, the smallest variance change as a function of resolution occurs for the Desmet and Govers method (Desmet, Govers, 1996a). In contrast, the largest changes in variance as a function of resolution occur for the Moore (Moore et al., 1991) and Boehner and Selige (Boehner, Selige, 2006) methods. The variance for a resolution of 90 meters is lower than the variance for a resolution of 30 metres for the Desmet and Govers method (Desmet, Govers 1996a) for the 6 parameter 2nd order polynom method (Bauer et al., 1985).

3. The Desmet and Govers method using the slope map determined by the 6 parameter 2nd order polynom method (Bauer et al., 1985) has a similar variance for resolutions of 1, 5, 10 metres, while for resolutions of 30 and 90 metres the variance is slightly higher. Using the slope map obtained by the 9 parameter 2nd order polynom method (Zevenbergen, Thorne 1987), the variance depending on resolution is higher compared to the slope map obtained by the 6 parameter 2nd order polynom method (Bauer et al., 1985).

4. The influence of the area of the recharge area – catchment area, calculated using a method other than Deterministic 8 (O'Callaghan, Mark, 1984), on the results of the LS coefficient determination was not tested in this paper.

5. Beneficial DTM used for LS modelling will be models with resolutions of 1, 5 and 10 metres.

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