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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Integration of remote sensing, RUSLE and GIS to model potential soil loss and sediment yield (SY)" *by* H. Kamaludin et al.

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General Comments

1)R-factor (rainfall erosivity) Two equations Morgan (1975) and Roose (1975) are mentioned and used. Luckily, Morgan's equation was derived from the data of the Malaysian region, but Roose derived his equation from Western African rainfall data and conditions. We know that annual rainfall alone is a very poor predictor of erosivity. E.g. in the northern UK, we may have 2000 mm of annual P, but a rather low annual erosivity (long lasting low intensity rains), where in drier countries with 500 to 750 mm of annual

rainfall may yield a much higher R (e.g. due to high intensity storms). In principle, and at least, the authors should show they validated the R-estimator for their region.

Answer: For the R factor, we have to make some adjustments and only use the Morgan (1975) formula because it was already evaluated for Malaysia case study. Validation for R factor was done by comparison of the analytical results (predicted) using GIS with the R factor from the Department of Irrigation and Drainage Malaysia (DID). The map showed similar pattern of rainfall distribution and the R factor value.

K-factor (soil erodibility) The authors give a table with values, which are realistic and the units are correct. However, at the bottom of this Table 1 (p.4586), we find for steepland K=0.5. Strange as in principle, the effect of slope steepness and length is evaluated with the LS-function and factor. Also the first value, when no information available, give K=0 sounds strange. I would at least give an overall average/median value then, being the first descriptor of a sample dataset (of K-values).

Answer: The K factor was determined using the combination of actual field sample measurements and secondary data. The secondary data is the soil map at the study area obtained from Department of Agriculture Malaysia. The value of K factor had been determined for 74 soil series in Malaysia, together with soil texture and hydrological soil group as given in a table of guideline book for erosion and sediment control in Malaysia obtained from Department of Irrigation and Drainage Malaysia (DID)(2010). The value K=0.000 was remove because all K value in the study was identified. Meanwhile K=0.5 was the steepland. Steepland in Malaysia is formed by coarse textured granitic rock. Thus, soil inherits the same physical characteristic. It was dominated by sandy material and prone to erosion. All correction was done in the manuscript.

LS factor (topographic) the used a grey literature reference for this factor (Bizuwerk et al, 2008). The equation here is from the old (outdated) USLE (1978). This equation has been evaluated (see Renard, 1993) as outdated, and was replaced by a multiple set of newer LS-functions in RUSLE. The authors should adapt this.

Answer: For the LS factor, there were a few of the correction from the literature reference. The LS factor in the formula by Wischmeir and Smith (1978) were used in both GIS (predicted) and field measurement calculation. In this study, the Bizuwerk at al., 2008) method was used only for calculation slope length and slope gradient in GIS environment. In the GIS environment, the slope length and slope steepness can be used in the single index. A few steps proposed by Bizuwerk (2008) can be used to evaluate the DEM image and convert to LS factor. Besides, the results obtained in GIS can be accepted by results obtained in the field measurement calculation. A table for the verification of these results was added in the manuscript.

C and P factors as mentioned earlier, no attempt was made to seriously parameterize these factors, using field and remote sensing observations. A simple NDVI to C-factor look-up table is used. Many tables, all rather specific to an area or region and cropping systems and vegetation types can be found in literature. Why these values? The C-factor is derived basically from canopy cover estimates (from NDVI, but also LAI leaf area index can be used as proxy), in combination with surface soil cover (e.g. stoniness, residue: : :) and some other sub-factors. The procedure is documented in RUSLE, but we don't find this back in this paper. At least, the authors should show how they validated their NDVI value conversion to C-factors for their land uses and vegetation cover types.

Answer: Satellite imagery is a source of information on percentage of vegetation cover, which can be related with an acceptable degree of accuracy to the Normalized Difference Vegetation Index (NDVI) (Mathieu et al., 1997). The relationship between NDVI and vegetation cover vary depending on the nature of the vegetation. In this study, the NDVI were used to estimate the C and P factor because NDVI can be determined the green and bare area. About 95% of the study area was covered by the different vegetation such as rubber, oil palm, horticulture, orchard, paddy and grass and only 5% of the study area covered urban area, recreational area and bare soil. The linear regression was applied to generate C factor. For C and P factor, the field measurement

had done by observation at the study area such as land use type, crop practice and percentage of land cover. A table for the verification of description of C and P factor in each sub-catchment will be attached in the manuscript.

SDR (sediment delivery ratio) and sediment yield The authors use a single SDR to catchment area bivariate regression function (eq. 8 p4575) for determining SDR and SY from soil loss (A). This has been documented long time ago, but recent evidence has indicated this bivariate model is over simplifying the situation far too much. Overall catchment land slope, drainage density, lithology and channel slope near the outlet determine largely sediment delivery from a catchment. In Figure 7 (p.4597), I'm surprised to see that a low SDR, leads to a high sediment yield and vice versa. I would think the opposite, if we assume that SDR = SY/(A or gross erosion).

Answer: In the calculation of sediment yield (SY), all the upstream value of A (or SE) were integrated and multiplied with the point value of SDR. We had done some adjustments for the value of SY and SDR. The value of SY should be higher than SDR. A table from the adjustment of SY and SDR in each sub-catchment was added in the manuscript and the SDR was removed from Fig. 7.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 10, 4567, 2013.

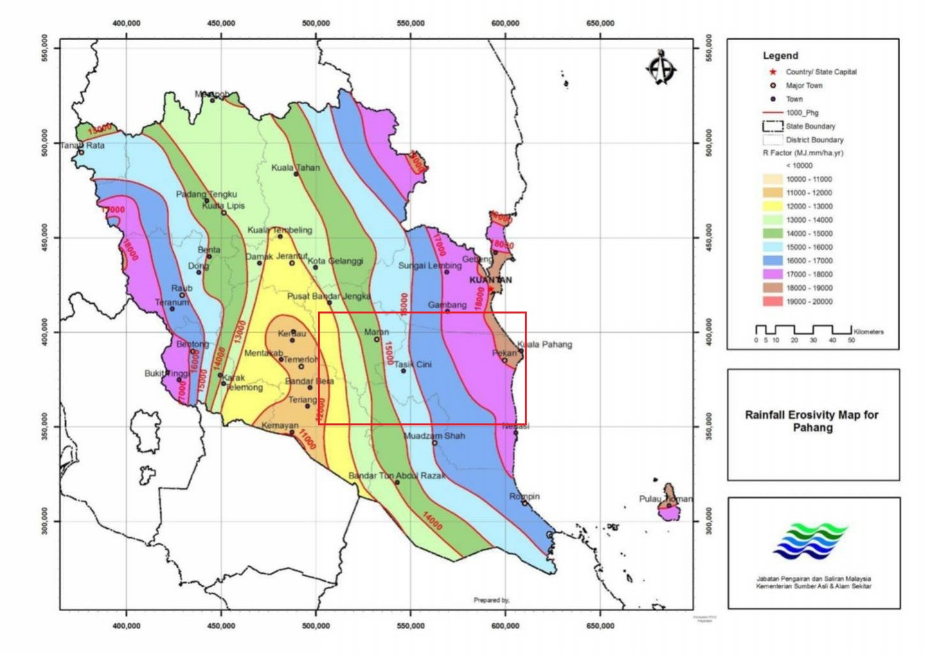

Fig. 1. Validation of R factor map from Department of Irrigation and Drainage Malaysia (DID)

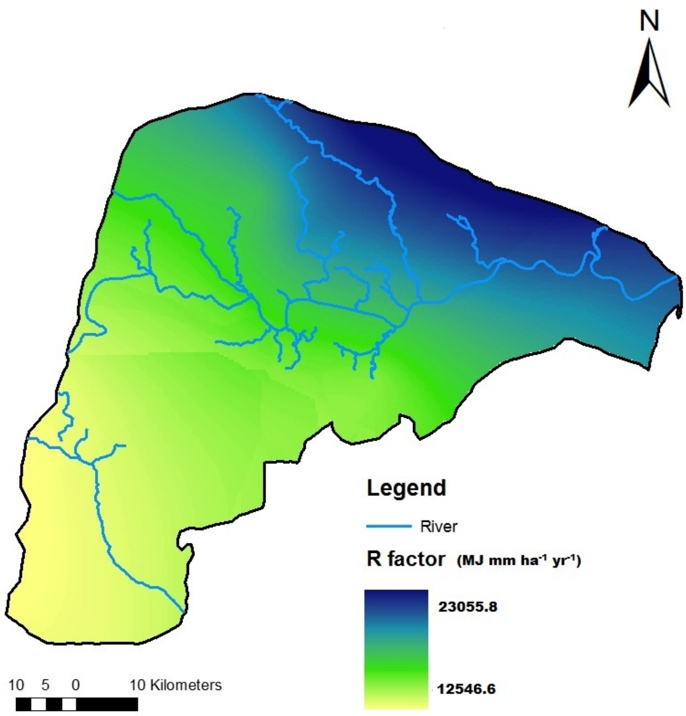

Fig. 2. R factor map produced using Morgan (1975)

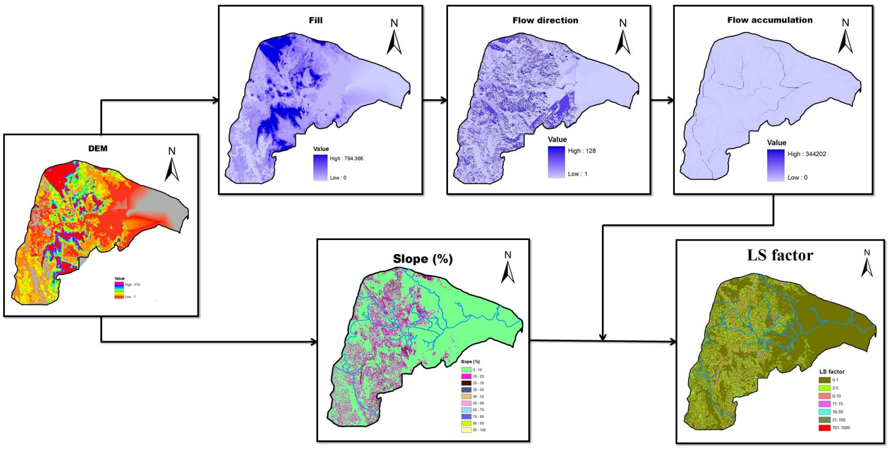

Fig. 3. The flow methology to produced the LS factor map from DEM

Sub-catchments	LS factor minimum value		LS factor maximum value	
	LS	0.065	LS	1.163
Lepar	SL(m)	50	SL(m)	70
	SG(°)	0.1	SG(°)	12
	LS	0.278	LS	1.128
Mentiga	SL(m)	70	SL(m)	53
	SG(°)	4	SG(°)	15
	LS	0.065	LS	3.794
Lekur	SL(m)	30	SL(m)	41
	SG(°)	0.1	SG(°)	30
	LS	0.065	LS	0.378
Chini	SL(m)	29	SL(m)	20
	SG(°)	0.1	SG(°)	8
	LS	0.065	LS	0.166
Temerlung	SL(m)	27	SL(m)	60
	SG(°)	0.1	SG(°)	2
	LS	0.141	LS	2.379
Luit	SL(m)	35	SL(m)	31
	SG(°)	5	SG(°)	25
	LS	0.064	LS	0.065
Jempol	SL(m)	25	SL(m)	30
	SG(°)	0.1	SG(°)	0.1
	LS	0.064	LS	0.202
Jengka	SL(m)	24	SL(m)	24
	SG(°)	0.1	SG(°)	4

SL = Slope Length (m)
SG = Slope Gradiet (°)

Fig. 4. LS factor value each sub-catchment from field measurement

Sub-catchments	Description	P factor	C factor
Lepar	Rubber, Palm Oil, Newly Cleared Plant & Bare Land	0.40, 0.70	0.28 - 1
Mentiga	Rubber & Palm Oil	0.40	0.18-0.28
Lekur	Rubber, Palm Oil & Forest	0.10, 0.40	0.001 - 0.28
Chini	Rubber, Palm Oil, Newly Cleared Plant & Orchard	0.10, 0.40, 0.70	0.001 - 1
Temerlung	Rubber, Palm Oil & Forest	0.10, 0.40	0.001 - 0.28
Luit	Palm Oil & Max Horticulture	0.40	0.001 - 0.45
Jempol	Rubber, Palm Oil & Forest	0.10, 0.40	0.001 - 0.28
Jengka	Rubber, Palm Oil & Forest	0.10, 0.40	0.001 - 0.28

Fig. 5. C and P factor value and description from field observation in the study area

Sub-catchments	SDR (tonnes/ha/yr)	SY (tonnes/ha/yr)
Lepar	0.2625	2.8925
Mentiga	0.2774	0.5194
Lekur	0.2880	2.5095
Chini	0.3289	4.9015
Temerlung	0.3169	5.2233
Luit	0.2734	5.9217
Jempol	0.3294	1.8844
Jengka	0.3865	0.4003

Fig. 6. SDR and SY field measurement value