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Hydrology and Earth System Sciences
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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)This paper presents an application of the RUSLE to a specific catchment in Peninsular Malaysia. While the paper is broadly well outlined and clearly structured, it is difficult to pinpoint the originality. It is an application of a well-established method (with remote sensing components) of predicting soil erosion to a case study catchment. Little (or no) attempt is made to generalize findings into a broader context, and I have various minor concerns with the method applied (see below). I suggest that this paper would need to be refocused with a more substantial original component before I would encourage publication in HESS. It may be that there

are aspects of the RS implementation that are novel: if this is the case, then they should be highlighted as such. However, I would be rather surprised if this were the case.

Answer: This study is precisely to determine the potential soil loss and sedimentation in an area of land used for agriculture. It has been divided into 8 sub-catchments, designed to see which area produce high soil loss and thus the sedimentation. This study focused on the analysis that has been proposed, which used remote sensing in prediction of potential soil loss and sedimentation. Remote sensing was used to determine the land use. To generate C and P factor, two scenes of satellite data with different date were used to compare the previous and current land use. However, field measurements were also conducted as the verification of the remote sensing analysis. Accuracy assessment has also been implemented and Kappa statistic was chosen to determine the accuracy of the remote sensing analysis and analysis of field measurements. The result of the analysis performed on each RUSLE parameters for verification will be attached in the manuscript.

2)The topic under investigation certainly has potential. The possibility that these values might change over time is not really mentioned, although this frames the context of the study in the introduction. Framed within a temporal study of land-use change (perhaps repeating analysis based on historical data to ascertain some form of change related to land-use, specifically forest clearance) then I would consider this much more publishable. Clearly, however, this depends on data availability.

Answer: Analysis of factor C and P in the RUSLE parameters was done using satellite data for the land use at study area for the previous 10 years period. However, there are no changes of forest clearance but the land use changes occurred from rubber to oil palm. In 1990, the study area was dominated by rubber cultivation. During 2010, the rubber cultivation was replaced by oil palm. The rubber and oil palm cultivation was not very noticeable difference in the soil loss.

3)The annual soil loss is classified into categories. What is the justification for these categories? Perhaps a sensitivity analysis would be appropriate? For example, "the SDR for each sub-catchment was observed to be very low to high" (P4579) is rather meaningless.

Answer: The classification of soil loss was done using the ordinal categories by Department of Agriculture Malaysia (2010). The classification from 0 to 1 tonnes/ha/yr were classified as very low soil loss, 1.1 to 5 tonnes/ha/yr were classified as low soil loss, 5.1 to 10 tonnes/ha/yr were classified as moderate soil loss, 10.1 to 20 tonnes/ha/yr were classified as high soil loss, 20.1 to 50 tonnes/ha/yr were classified as severe soil loss and 50.1 to 100 tonnes/ha/yr were classified as extreme soil loss. But, if the soil loss is over than 100 tonnes/ha/yr it is classified as exceptional soil loss. As was mentioned previously, Kappa statistic was chosen for the sensitivity assessment for soil loss between the remote sensing analysis and field measurement analysis. The result showed that the overall classification accuracy was 89% and the overall kappa statistic was 0.7. The result of soil loss and sedimentation in each sub-catchment is presented in the manuscript.

4)The broader issue here is that a number of empirical equations, parameters and classifications are used in this analysis, and yet, the results are stated as fact, with no consideration of errors and, as far as I can tell, no validation. This impacts the reliability of the results and should be considered before publication.

Answer: The validation result for the RUSLE parameters, soil loss and sedimentation in each sub-catchment will be presented in manuscript.

Specific Comments

There are some minor aspects of the method that require clarification or justification:

(1)What is the physical meaning of the m parameter in equ. 2 and Table 2?

Answer: The m parameter is an index used in slope variation. The value of m varies

from 0.2 to 0.5 depending on the slope (%). The slope (%) is directly derived from the Digital Elevation Model (DEM). The min of the slope value at the study area was over than 5% slope, and then the m value was 0.5.

(2) Is the 'cell value' in equ. 3 the cell size?

Answer: The cell value in equ. 3 represented the cell size or area of pixel size. The cell size used in the analysis was 100x100m.

(3) P4573 L8 suggests that some form of validation has taken place. This is not presented.

Answer: R factor validation was done by comparison of the analytical results using GIS with the R factor map from the Department of Irrigation and Drainage Malaysia (DID). The map showed similar pattern of rainfall distribution and the R factor value. Some adjustments for R factor were made, and only the Morgan (1975) formula was used because it was already evaluated for Malaysia's case study.

(4) Parameter S represents soil structure in equation 7. This is not elaborated on.

Answer: Parameter S in equation 7 was referred to the soil structure. Nomograph to calculate the K-factor was introduced by Wischmeir at al., (1971), soil structure was divided into 4. There were 1) Very fine granular 2) Fine granular 3) Medium or coarse granular 4) Blocky, platy or massive. The field observation showed that the study area consists of fine granular in soil structure. This explanation was added in the manuscript.

(5) What secondary data was used to evaluate K? (P 4574 L9)

Answer: The K factor was determined using the combination of field measurements and secondary data. Soil map in the form of soil series was obtained from the Department of Agriculture Malaysia (DOA). The value of K of these soil series was obtained from the Department of Irrigation and Drainage Malaysia (DID).

(6) A regression between NDVI and C is mentioned (P4575 L3) but nowhere is this

presented.

Answer: The equation of the linear regression between NDVI value and C factor were:- y = -0.5293x + 0.3912. This equation was added in the manuscript .

(7) In the calculation of sediment yield, should all upstream values of A (or SE) not be integrated and multiplied with the point value of SDR? I am not certain of this, but this seems to make more physical sense to me, given the calculation of SDR. At the very least, it deserves some thought.

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 will be given in the manuscript.

P4582 L6: this correlation is most spurious, given equation 9!

Answer: This sentence was removed. And the paragraph was restructured

Technical corrections

1) P4568 L21: reword first sentence. It is rather vague.

Answer: The sentence in the P4568 L21 was reword. – Higher quality of life and human development need vast amounts of forest area exploration.

P4569 L14: I would avoid calling RS 'famous'!

Answer: The word 'famous' was removed from the text.

2) Table 2 is referenced before Table 1.

Answer: P4586 for Table 1: m value for LS factor and P4587 for Table 2: Soil classification and K value based on Malaysian Soil Series

3) P4573 L15: units of P?

Answer: P value = the mean annual precipitation unit is mm (millimetre).

4) P4573 L20: what is the source of this equation? Again, units missing.

Answer: The K factor was computed using the algebraic approximation by Wischmeier and Smith, (1978). S.I unit tonnes.h.MJ-1 mm-1

5) P4578 L23: reference to Fig 5. This Figure is classified and does not show the value suggested.

Answer: The value was added at the legend in Fig. 5.

6) Figure 4: classification is unclear.

Answer: The Fig. 4. was enhanced.

7) Figure 7: Is this the percentage of total soil loss? Is percentage of SDR meaningful?

Answer: The SDR in Fig. 7. was removed .

8) Figure 8 is unclear. Which is upstream? Which are the specific tributaries? The data need plotting on different scales.

Answer: The Fig. 8. was changed.

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

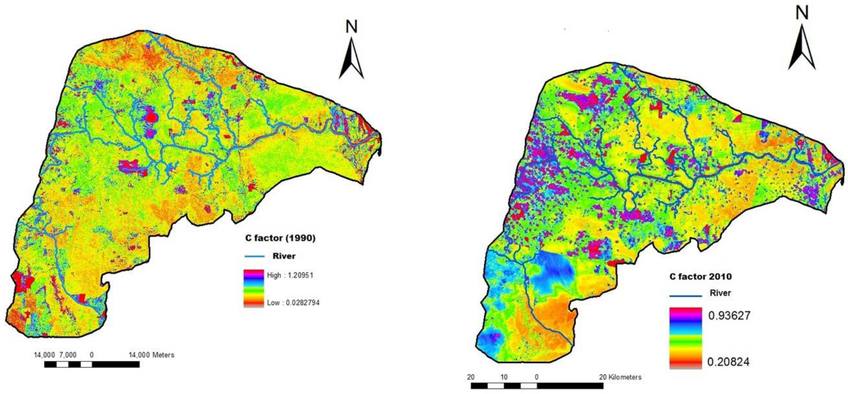

Fig. 1. Difference the C factor in 1990 and 2010

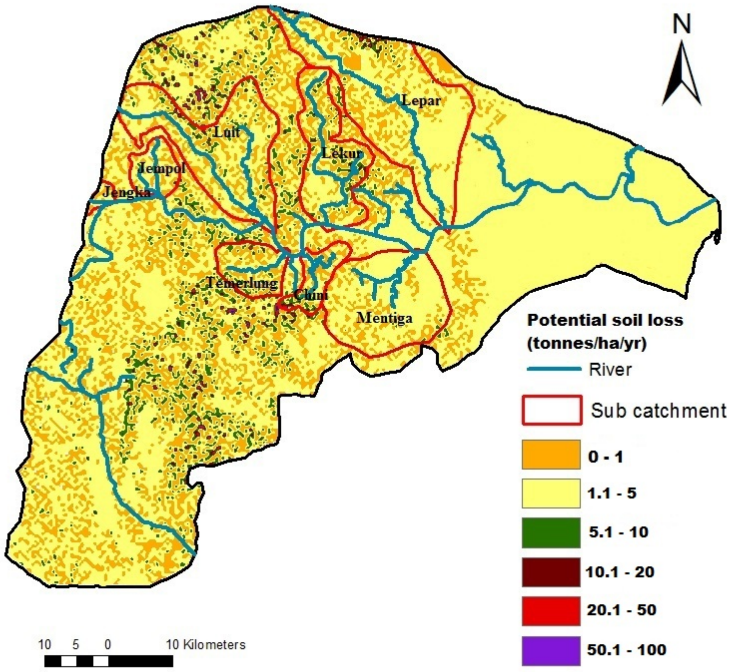

Fig. 2. Annual soil loss classified into categories

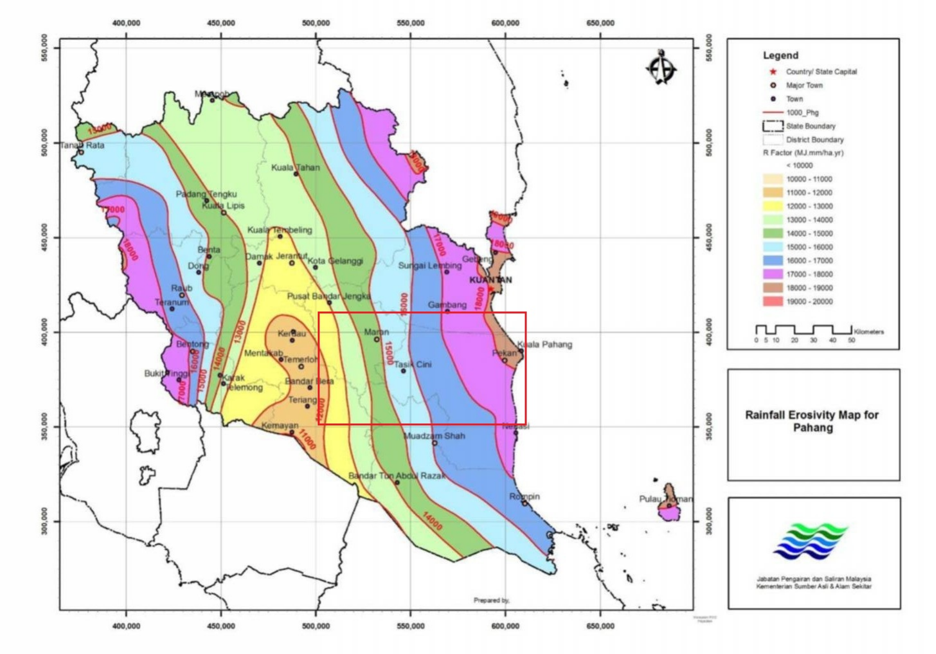

Fig. 3. Validation of R factor map from Department of Irrigation and Drainage Malaysia (DID)

Sub-catchments	Area (Km2)	Amax (tonnes/ha/yr)*	Amax (tonnes/ha/yr)**
Lepar	418	11.02	1.59
Mentiga	253	1.87	1.21
Lekur	179	8.71	0.82
Chini	53	14.9	0.37
Temerlung	75	16.48	0.16
Luit	288	21.65	4.63
Jempol	53	5.72	0.1
Jengka	12	1.04	0.43

*GIS calculation
**Field measurement calculation

Fig. 4. Soil loss value by two approaches (GIS calculation and field measurement calculation)

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. 5. SDR and SY value 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. 6. C and P factor value in each sub-catchment from field observation

Sub-catchments	OM (%)	Hydraulic Conductivity (cm h-1)	Soil structure	N1	N2	K value
Lepar	1.29 - 8.39	0.91 - 6.88	2	14.47 - 42.40	41.39 - 85.94	0.086 - 0.243
Mentiga	1.81 - 6.64	2.99 - 63.16	2	6.70 - 20.72	63.25 - 101.03	0.004 - 0.101
Lekur	0.91 - 3.09	0.34 - 36.09	2	15.51 - 49.14	55.68 - 94.69	0.083 - 0.279
Chini	3.51 - 3.87	0.44 - 1.01	2	35.52 - 38.16	45.58 - 48.58	0.095 - 0.166
Temerlung	0.46 - 1.41	1.57 - 3.79	2	23.19 - 32.01	79.88 - 81.93	0.158 - 0.221
Luit	1.49 - 7.81	0.49 - 8.47	2	11.29 - 52.59	35.59 - 86.99	0.058 - 0.219
Jempol	1.73 - 4.81	0.52 - 3.83	2	18.14 - 35.02	69.92 - 90.23	0.112 - 0.185
Jengka	4.51 - 7.59	0.28 - 0.42	2	25.01 - 39.19	52.39 - 61.53	0.131 - 0.188

OM = Organic Matter

Soil Structure:
1 = Very Fine Granular
2 = Find Granular
3 = Medium or Coarse Granular
4 = Blocky, Planty or Massive

N1 = Clay + Very Fine Sand (0.002mm - 0.125mm)
N2 = Clay + Very Fine Sand + Sand (0.125mm - 2mm)

Fig. 7. K factor value and calculation from field measurement

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

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

Fig. 8. LS factor value from field measurement of each sub-catchment

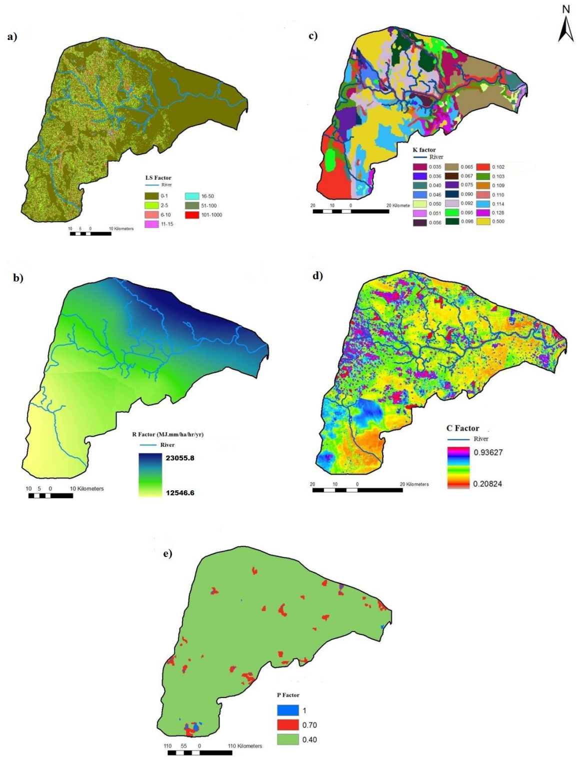

Fig. 9. The RUSLE parameters by GIS calcluation

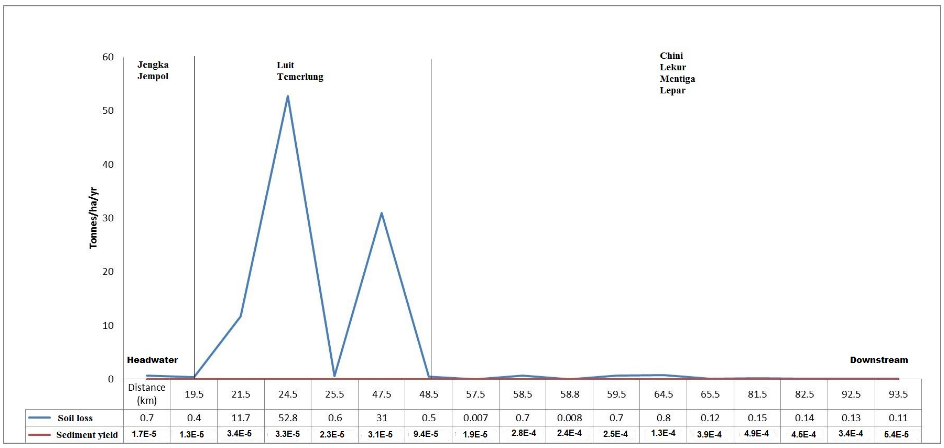

Fig. 10. The soil loss and sediment yield from headwaters to downstream (river mouth)