Response to Decision Letter

Dear Dr. Paolo Tarolli and referee,

We are very pleased to learn from your letter about revision for our manuscript which entitled _"Dangerous degree forecast of soil and water loss on highway slopes in mountainous areas using RUSLE model"._

We greatly appreciate reviewer's thoughtful suggestions concerning improvement to our paper. These comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our researches.

Thank you for your consideration!

Sincerely yours,

*Corresponding Author: Shi Qi

P.S.

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Response to review's comments for nhess-2017-406-RC2

Reviewer's #2 comments:

Comment 1: This manuscript has improved considerably since the original submission, however two major issues remain (plus some minor issues outlined below). These are (a) it is not clear what the significance of this work is beyond a comprehensive case study. Please emphasise how this work advances our knowledge, and how others could use it beyond this location. (b) There are still issues with communication. Primarily, the lack of explanation of what the RULSE model is in the introduction RUSLE, and the number of large tables which are difficult to quickly draw any conclusions from The language is significantly improved, but in places remains a little dense.

Response 1: (a) This study analysis the characteristics of soil erosion in the process of expressway construction, and improves the following aspects on the basis of previous research: (1) In order to be closer to the actual situation, we divide the highway slope into natural unit and artificial unit, and calculate the amount of soil loss from the slope surface to the pavement by the slope surface catchment unit, which is more in line with the actual situation, and this idea can be popularized; (2) We consider the spatial heterogeneity of linear engineering of expressway, then the rainfall factor is spatially interpolated, it has made up for the defects of rainfall data usually used by rainfall stations in previous studies. (3) We modify the parameters of the artificial slope by means of actual survey, runoff plot observation and other means, and the parameters of the artificial slope are corrected by referring to the form of the project and the materials used.

(b) RUSLE is a set of mathematical equations that estimate average annual soil loss and

sediment yield resulting from interrill and rill erosion (Renard et al., 1997; Foster et al., 1999; Zerihun et al., 2018; Toy et al., 2002). It is derived from the theory of erosion processes, more than 10,000 plot-years of data from natural rainfall plots, and numerous rainfall-simulation plots. RUSLE is an exceptionally well-validated and documented equation. A strength of RUSLE is that it was developed by a group of nationally-recognized scientists and soil conservationists who had considerable experience with erosional processes. (Soil and Water Conservation Society, 1993).

Besides, we have perfected the language of the manuscript, hoping to meet the requirements of reviewers and editor.

Comment 2: There are still many statements made without any reference to the literature. For example, line 55 "According to statistics, with the development of highway construction in China, slope areas reach 200-300 million m^2 56 each year". Please check throughout for statements made without supporting reference to the literature.

Response 2: Thank you for your patience and careful work! We have made correction according to your comments. Details are in following paragraph and manuscript.

According to statistics, with the development of highway construction in China, slope areas reach 200–300 million m^2 each year (Dong and Zeng 2003).

Reference:

Dong, H., Zeng, H.: Discussion on the current situation and the future of China highway construction. Technology & Economy in Areas of Communication (TEAC), 5(3):17-18, 2003 (in Chinese).

Comment 3: Line 59 "Compared with the soil and water loss on forestlands and farmlands, which on subgrade slopes is special". This sentence is not clear.

Response 3: Thank you for your comments. We have followed your advice to revise it. Details are in following paragraph and manuscript.

The soil and water loss of roadbed slope is different from that of soil and water in woodland and farmland.

Comment 4: Line 69 "The use of revised universal soil loss equation (RUSLE) models as predictive tools for the quantitative estimation of soil erosion has been maturing for a long time" add references.

Response 4: Thank you for your comments. We have followed your advice to add references. Details are in following paragraph and manuscript.

The use of revised universal soil loss equation (RUSLE) models as predictive tools for the quantitative estimation of soil erosion has been maturing for a long time (Panagos et al., 2018; Cunha et al., 2017; Taye et al., 2017; Renard 1997)

References:

Panagos, P., Standardi, G., Borrelli, P., Lugato, E., Montanarella, L., Bosello, F.: Cost of

agricultural productivity loss due to soil erosion in the European union: from direct cost evaluation approaches to the use of macroeconomic models. Land Degradation & Development. 2018.

Cunha, E. R. D., Bacani, V. M., Panachuki, E.: Modeling soil erosion using RUSLE and GIS in a watershed occupied by rural settlement in the Brazilian Cerrado. Natural Hazards, 85, 1-18, 2017.

Taye, G., Vanmaercke, M., Poesen, J., Wesemael, B. V., Tesfaye, S., Teka, D., et al.: Determining RUSLE P-and C-factors for stone bunds and trenches in rangeland and cropland, North Ethiopia. Land Degradation & Development, 29(5), 2017.

Renard, K. G.: Predicting soil erosion by water: A guide to conservation planning with the Revised Universal Soil Loss equation (RUSLE), 1997.

Comment 5: Line 72 onwards. You immediately go into detail about the RULSE model parameters/evolution without giving any background to what the RULSE models/equations are. First introduce what the model/equation is before talking about specific parts (e.g., LS).

Response 5: We are grateful to the reviewer for pointing out this comment, we have made supplement according to your comments. Details are in following paragraph and manuscript.

RUSLE is a set of mathematical equations that estimate average annual soil loss and sediment yield resulting from interrill and rill erosion (Renard et al., 1997; Foster et al., 1999; Zerihun et al., 2018; Toy et al., 2002). It is derived from the theory of erosion processes, more than 10,000 plot-years of data from natural rainfall plots, and numerous rainfall-simulation plots. RUSLE is an exceptionally well-validated and documented equation. A strength of RUSLE is that it was developed by a group of nationally-recognized scientists and soil conservationists who had considerable experience with erosional processes. (Soil and Water Conservation Society, 1993).

The use of revised universal soil loss equation (RUSLE) models as predictive tools for the quantitative estimation of soil erosion has been maturing for a long time...

References:

Renard, K. G., Foster, G. R., Weesies, G. A., McCool, D. K., Yoder, D. C.: Predicting soil erosion by water-a guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE). United States Department of Agriculture, Agricultural Research Service (USDA-ARS) Handbook No.703. United States Government Printing Office: Washington, DC. 1997.

Foster, G. R., Weesies, G. A., McCool, D. K., Joder, D. C., Renard, K. G.: Revised Universal Soil Loss Equation User's Manual. Gov. Print. Office, Washington D.C. (48p), 1999.

Zerihun, M., Mohammedyasin, M. S., Sewnet, D., Adem, A. A., Lakew, M.: Assessment of soil erosion using RUSLE, GIS and remote sensing in NW Ethiopia. Geoderma Regional, 12, 83-90, 2018.

Toy, T. J., Foster, G. R., Renard, K. G.: Soil Erosion: Processes, Prediction, Measurement, and Control. 2002

Soil and Water Conservation Society. RUSLE user's guide. Soil and Water Cons. Soc. Ankeny, IA. 164pp, 1993.

Comment 6: Line 107 use gender neutral pronouns (i.e., use "they", not "he").

Response 6: Thank you for your careful work! We have carefully corrected these mistakes according to your comment. Details are in the following paragraph and manuscript.

Zhang (2016) investigated the spatio-temporal distribution of soil erosion in ring expressway before and after construction process, they used land use/cover map of Ningbo City in 2010, topographic map, map of North Ring expressway and field survey data was collected to derive digital elevation model (DEM).

Comment 7: Line 177 state what the R factor is. Is this rainfall and runoff? If so, these should have separate parameter notations.

Response 7: Thank you for your comments! We have followed your advice to explain and revise it. Details are in the following paragraph and manuscript.

The R factor in this sentence refers to the rainfall.

In order not to cause ambiguity, we revised the sentence as follows:

In determining the predictive parameters of the model, the rainfall is obtained by spatial interpolation.

Comment 8: Line 198 you state the difference in precipitation but it is not clear what the values correspond to in terms of difference.

Response 8: Thank you for your comments! We have followed your advice to revise it. Details are in the following paragraph and manuscript.

Revised:

Between May and the middle of October, the area experiences wet season characterized by abundant rainfall, concentrated precipitation, and increased rain at night, the variation on precipitation is from 400 to 2000mm, and most of the regions are between 800 to 1800mm (Fei et al., 2017; Zhang et al., 2017).

Comment 9: Line 203 "The terminal is across the river from the old street of Vietnam". This is unclear.

Response 9: Thank you very much! We discussed it on the basis of your comments, we agreed to delete the sentence, but this will not affect the completeness and accuracy of this part. Details are in the manuscript.

Comment 10: Line 206. You state here that most of the slope is below 30 degrees, yet in the introduction, you state that most highway slopes are above 30 degrees. This makes the justification for this case study somewhat weak if it is not representative of the slopes of other

road areas. Please clarify.

Response 10: Thank you for your comments! We have followed your advice to explain and revise it. Details are in the following paragraph and manuscript.

Study Area:

"The slopes on both sides rise and fall, and most of the valleys constitute "V"- and "U"-shaped sections. The <mark>natural slopes</mark> on both sides are mostly below 30°". The marked part means that the slope of mountain.

Introduction:

"Traditional soil and water conservation research focuses on slopes with 20% grade or below, but the <mark>highway subgrade slope of steep slopes</mark> is generally greater than 30% (Zhou 2010)." The mark part refers to subgrade slope.

Revised:

Traditional soil and water conservation research focus on slopes with 20% grade or below, but the <mark>roadbed slope of the highway</mark> is generally greater than 30% (Zhou 2010). The marked part means that article slope.
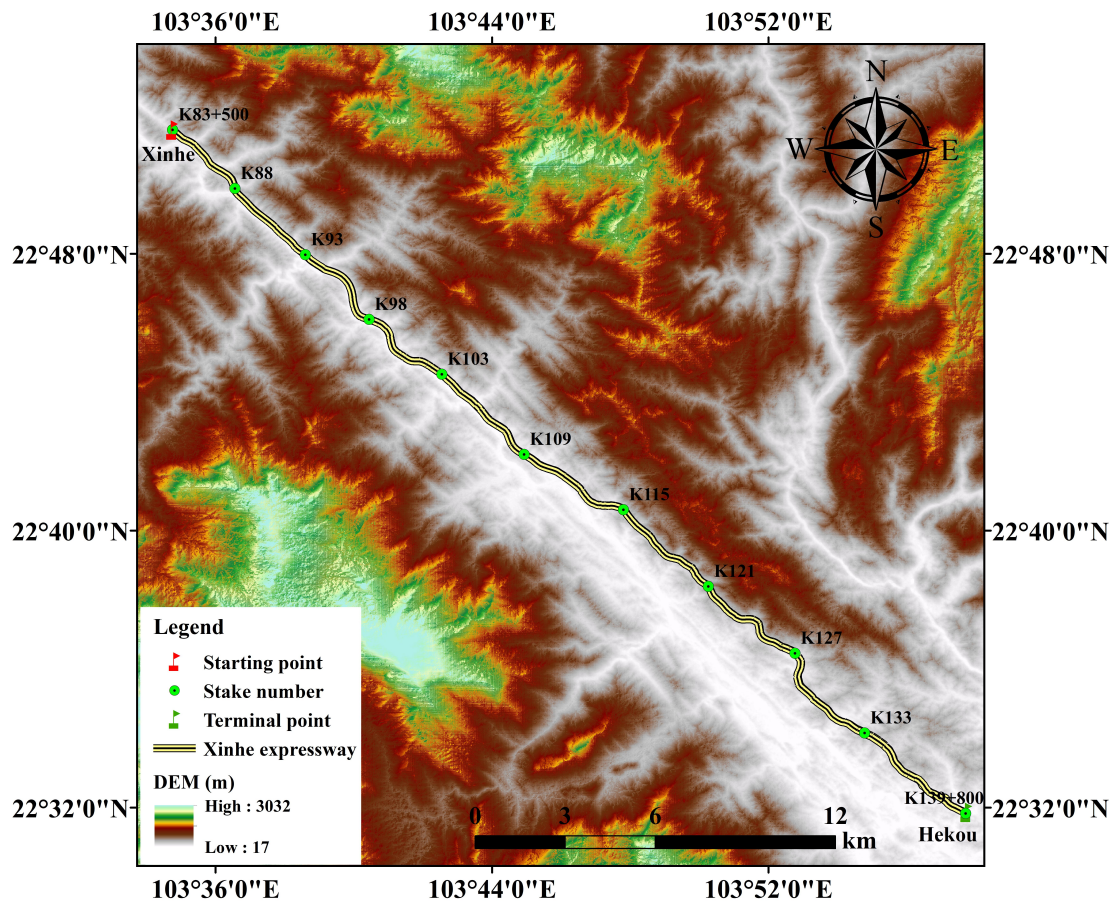
In order to distinguish these two types of slopes, the schematic diagram is as follows:

Comment 11: Figure 1 part C give units in the legend (I assume this is metres above sea level).

Response 11: Thank you for your comments! We have followed your advice to revise it.

Comment 12: Figure 2 is mentioned in text before figure 1. Re-order the figures and include the new figure 1 (formerly figure 2) in the introduction.

Response 12: Thank you for your careful work! We have carefully corrected these mistakes according to your comment. Details are in the following paragraph and manuscript.

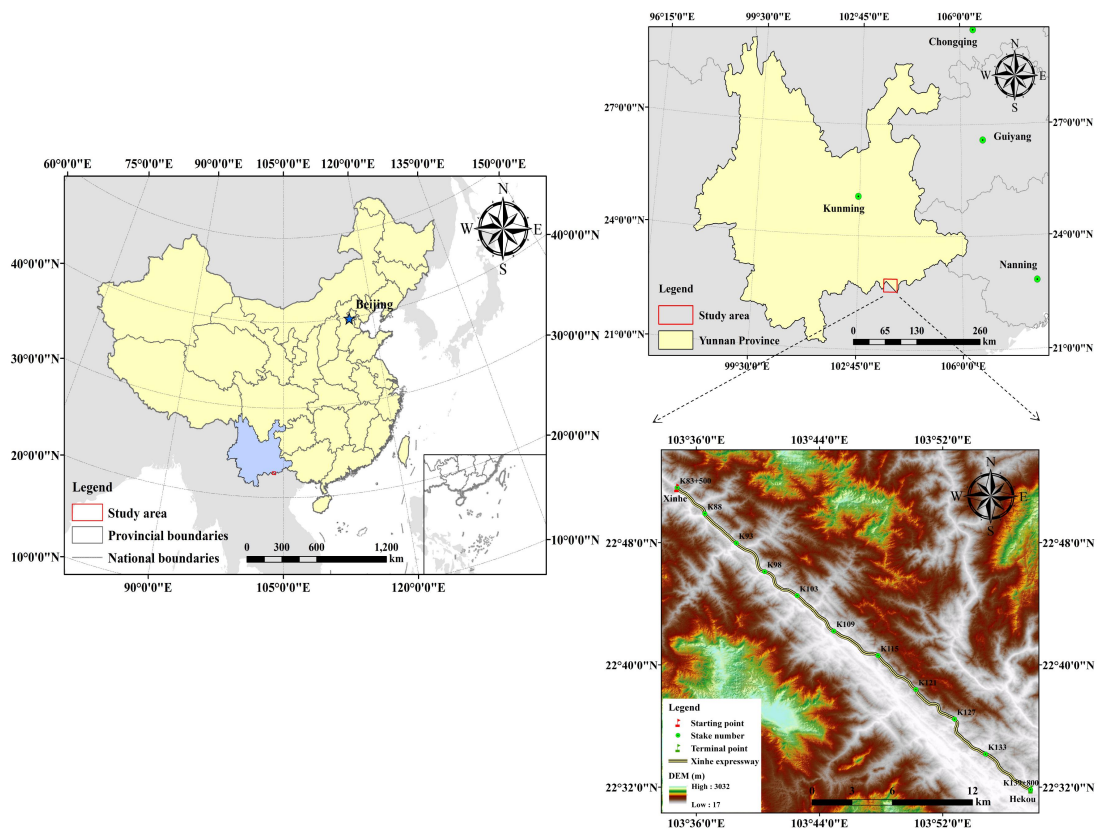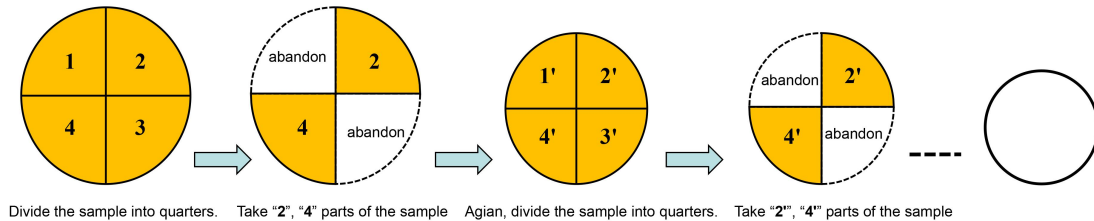**Figure 1.** Soil erosion produced by rainwash on slope

Figure 2. Overview of study region

Comment 13: Line 239 state what the quartering method is and give a reference for this.

Response 13: Thank you for your comments! We have followed your advice to explain and revise it. Details are in the following paragraph and manuscript.

Method of coning and quartering: It means that each pile is made into a uniform conical, and compressed into a cone and then divided into four equal parts by a cross frame. The schematic diagram is as follows:

Divide the sample into quarters.　　Take "**2**", "**4**" parts of the sample　　Agian, divide the sample into quarters.　　Take "**2'**", "**4'**" parts of the sample

Reference:

Oyekunle, J. A. O., Ogunfowokan, A. O., Torto, N., Akanni, M. S.: Determination of organochlorine pesticides in the agricultural soil of Oke-Osun farm settlement, Osogbo, Nigeria. Environmental Monitoring & Assessment, 177(1-4), 51, 2011.

Comment 14: Line 254 this description of the RULSE model is good, and should be included much earlier on in the introduction, even if this results in some repetition.

Response 14: We greatly appreciate your valuable suggestion concerning improvement to this paper. We have followed your advice to adjust it. Details are in following paragraph and manuscript.

The contents added in the introduction are as follows:

RUSLE is a set of mathematical equations that estimate average annual soil loss and sediment yield resulting from interrill and rill erosion (Renard et al., 1997; Foster et al., 1999; Zerihun et al., 2018; Toy et al., 2002). It is derived from the theory of erosion processes, more than 10,000 plot-years of data from natural rainfall plots, and numerous rainfall-simulation plots. RUSLE is an exceptionally well-validated and documented equation. A strength of RUSLE is that it was developed by a group of nationally-recognized scientists and soil conservationists who had considerable experience with erosional processes. (Soil and Water Conservation Society, 1993).

Comment 15: Line 261 please give more detail on what the units MJ·mm/(hm^2·h) means and ensure this is in SI notation.

Response 15: Thank you for your comments! We have followed your advice to explain it. Details are in the following paragraph and manuscript.

$$A = R \cdot K \cdot L \cdot S \cdot C \cdot P, \qquad (1)$$

where A is the average soil loss per unit area by erosion (t/hm^2), R is the rainfall erosivity factor (MJ·mm / (hm^2·h)), K is the soil erodibility factor (t·hm^2·h / (hm^2·MJ·mm)), L is the slope length

factor, S is the steepness factor, C is the cover and management practice factor, and P is the conservation support practice factor. The values of L, S, C, and P are dimensionless.

The R factor is an expression of the erosivity of rainfall and runoff at a particular location. Analyses of data indicated that when factors other than rainfall are held constant, soil loss is directly proportional to a rainfall factor composed of total storm kinetic energy (E) times the maximum 30-min intensity (I_{30}) (Wischmeier and Smith, 1958).

By definition, the value of EI for a given rainstorm equals the product, total storm energy (E) times the maximum 30-min intensity (I_{30}), where E is in is in hundreds of foot-fons per acre and I_{30} is in inches per hour (in/h). El is an abbreviation for energy-times-intensity, and the term should not be considered simply an energy parameter. The data show that rainfall energy, itself, is not a good indicator of erosive potential. The storm energy indicates the volume of rainfall and runoff, but a long, slow rain may have the same E value as a shorter rain at much higher intensity. Raindrop erosion increases with intensity. The I_{30} component indicates the prolonged-peak rates of detachment and runoff. The product term, EI, is a statistical interaction term that reflects how total energy and peak intensity are combined in each particular storm. Technically, it indicates how particle detachment is combined with transport capacity.

The energy of a rainstorm is a function of the amount of rain and of all the storm's component intensities. Median raindrop size increases with rain intensity (Wischmeier and Smith 1958), and terminal velocities of free-falling waterdrops increase with increased drop-size (Gunn and Kinzer 1949). Since the energy of a given mass in motion is proportional to velocity-squared, rainfall energy is directly related to rain intensity.

References:

Gunn, R., Kinzer, G. D.: The terminal velocity of fall for water droplets. Journal Met. 6: 243-248, 1949.

Wischmeier, W. H., Smith, D. D.: Rainfall energy and its relationship to soil loss. Trans.am.gephys.union, 39(2), 285-291,1958.

Comment 16: Line 272 This sentence is very long and unclear. Please break up into shorter statements.

Response 16: We greatly appreciate your valuable suggestion concerning improvement to this paper. We have followed your advice to revised it. Details are in following paragraph and manuscript.

Line 272: The natural and artificial slope catchment watershed was divided into uniform prediction units on the basis of the extracted graphical units of the artificial and natural slope catchments and according to the differences in aspect, slope, land use, and water conservation measures, such as property.

On the basis of the extracted graphical units of the artificial and natural slope, the natural and artificial slope was divided into a uniform prediction unit according to the aspect, slope, land use,

water conservation measures.

Comment 17: Figure 3. This figure caption needs much more detail to explain how this works. Figure captions should be standalone so that the reader could fairly easily look at the figure and understand it without having to read the body text.

Response 17: We greatly appreciate your valuable suggestion concerning improvement to this paper. We have followed your advice to adjust it. Details are in following paragraph and manuscript.

Figure 3 contains the contents of 2.3 and 3.1, which is a summary of the two parts. Therefore, in the original manuscript, Figure 3 as part of the content of 2.3 is one-sided. In order not to cause misunderstanding between readers and peer reviewers, at the same time, it is also conducive to the accurate interpretation of the manuscript, after discussion, all authors believe that Figure 3 should be deleted.
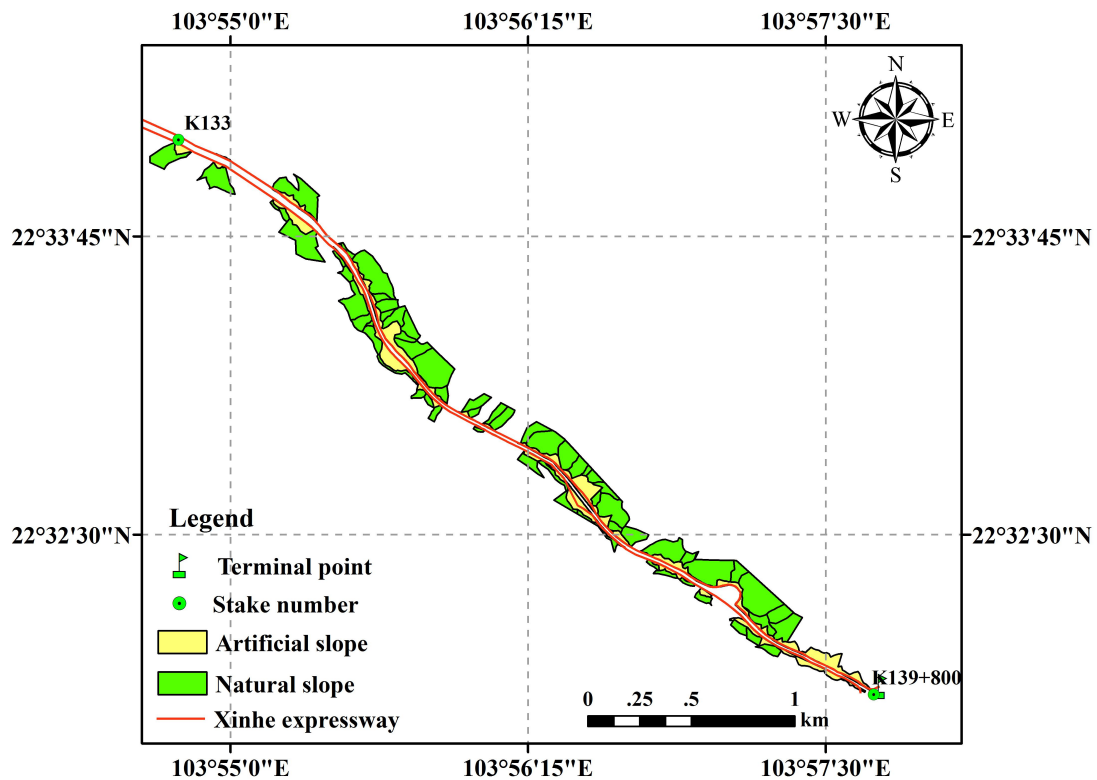
Comment 18: Line 298 incorrect Harvard reference (McCool).

Response 18: We are grateful to the reviewer for pointing out this mistake. We have followed your advice to revise it. Details are in following paragraph and manuscript.

Mccool (1987) stated that slope length varies within a 10 m range and has only a small effect on results.

Comment 19: Figure 4 does not look like it shows 1236 units-are we looking at a subset here? If so, state this in the figure caption.

Response 19: We are in complete agreement with your comment. The Figure 4 expresses a subset. So, we have followed your advise to revise it. Details are in following paragraph and manuscript.

Figure 4. Division results of prediction units (A subset-6.8 km)

Comment 20: Line 324 state method of interpolation.

Response 20: Thank you for your comments! We have followed your advice to explain and revised it. Details are in the following paragraph and manuscript.

The method here refers to the co-kriging.

The P and I_{30} values along the highway were obtained by the method of co-kriging calculations.

In the process of co-kriging calculations, combined with environmental characteristics, a number of factors that affect precipitation are introduced.

Comment 21: Line 329 (and more generally throughout) you often state what method you used with no justification as to why this is an appropriate method. Please give further information why mean standard error is an appropriate criteria.

Response 21: Thank you for your comments! We have followed your advice to explain it. Details are in the following paragraph.

The mean standard error reflects the variation of the sample mean to the population means, thus reflecting the size of sampling error, it is an indicator of precision of measurement results.

This is the basic knowledge of statistics. Such a method is often used for analysis of similar studies (Yang et al., 2008; Liu 2014)

We have done several error analysis, the result shows that there is little difference between

the results of the analysis. Considering the structure of the whole article without lengthy text, so it is expressed only by mean standard error.
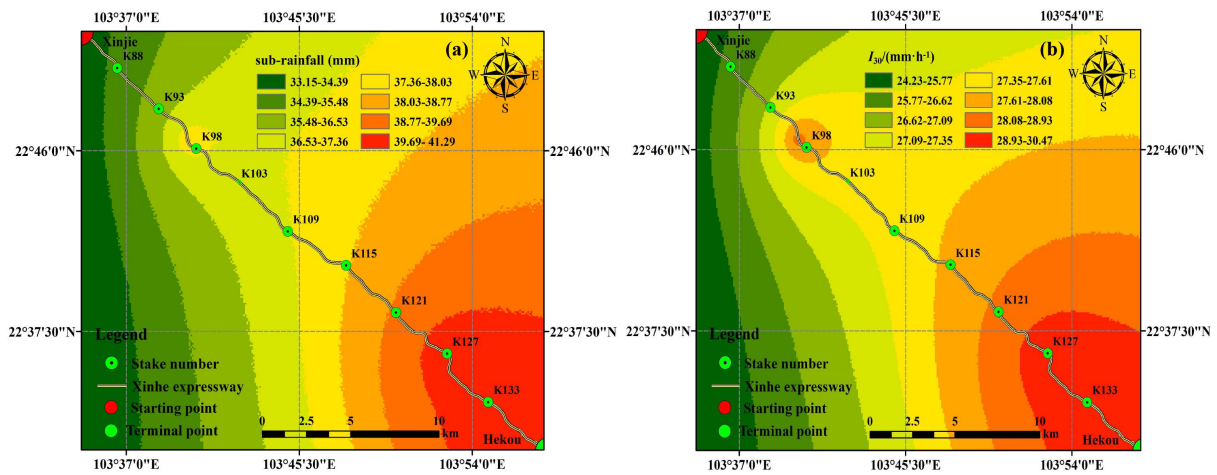
Reference:

Yang, Q. Z., Li, J., Xu, M.: Study on Characteristic of Rainfall Infiltration in Typical Farmland Soil in the Lower Reach of Yangtze River. PLATEAU METEOROLOGY, b12,175-182, 2008 (in Chinese).

Liu, J. M.: Numerical Simulation and Prediction of Groundwater of Large-scale Irrigation in Northern China: The Case of Baoyang Irrigation Area, Shaanxi, China. Water Resource & Architectural Engineering, 2014.

Comment 22: Figure 5 and 6 I suggest combining these into a two part figure.

Response 22: Thank you for your comments! We have followed your advice to adjust it. Details are in following paragraph and manuscript.

Figure 5(a). Interpolation results of secondary rainfall for June 5, 2014;
Figure 5(b). Interpolation results of I_{30} for June 5, 2014

Comment 23: Figure 7 it is very difficult to see any variation in R due to the units being very small. I suggest showing a sub figure with zoomed sections.

Response 23: We greatly appreciate your valuable suggestion concerning improvement to this paper. We have followed your advice to adjust it. We added a subgraph, hoping to reflect the variation of R value as far as possible. Details are in following paragraph and manuscript.
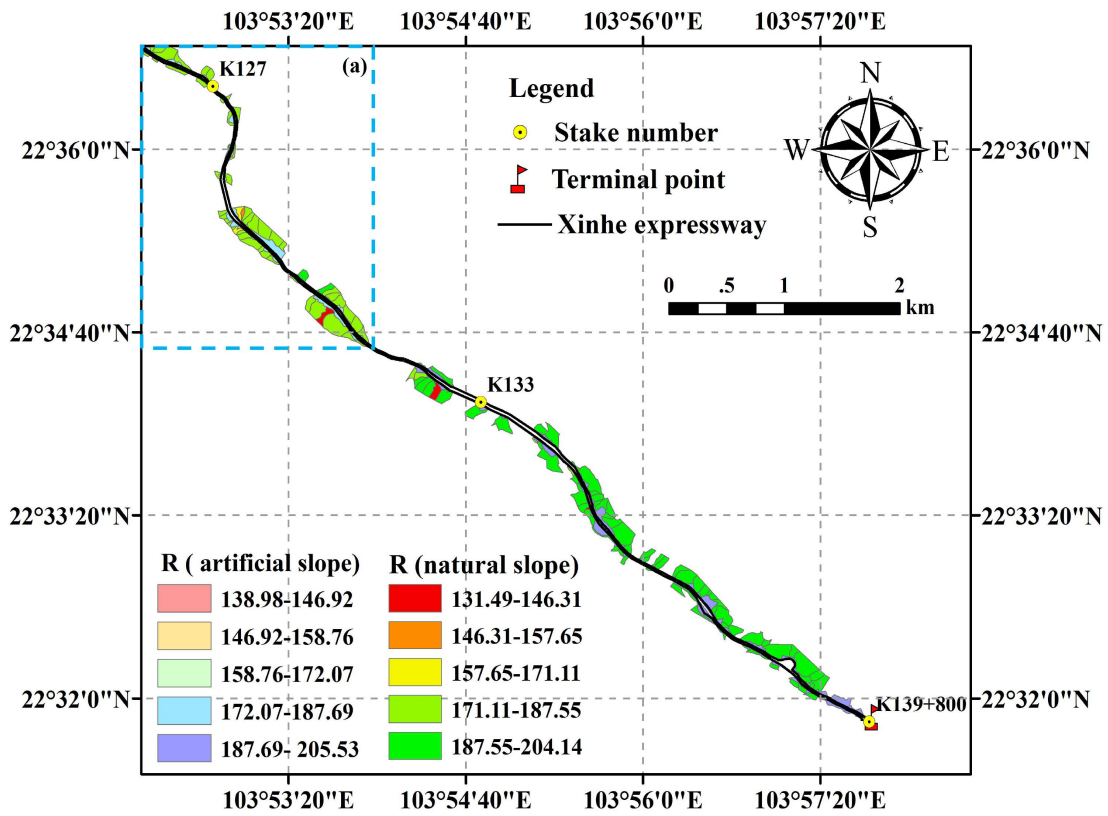
Figure 7. Spatial distribution map of rainfall erosivity factors (K127–K139+800)
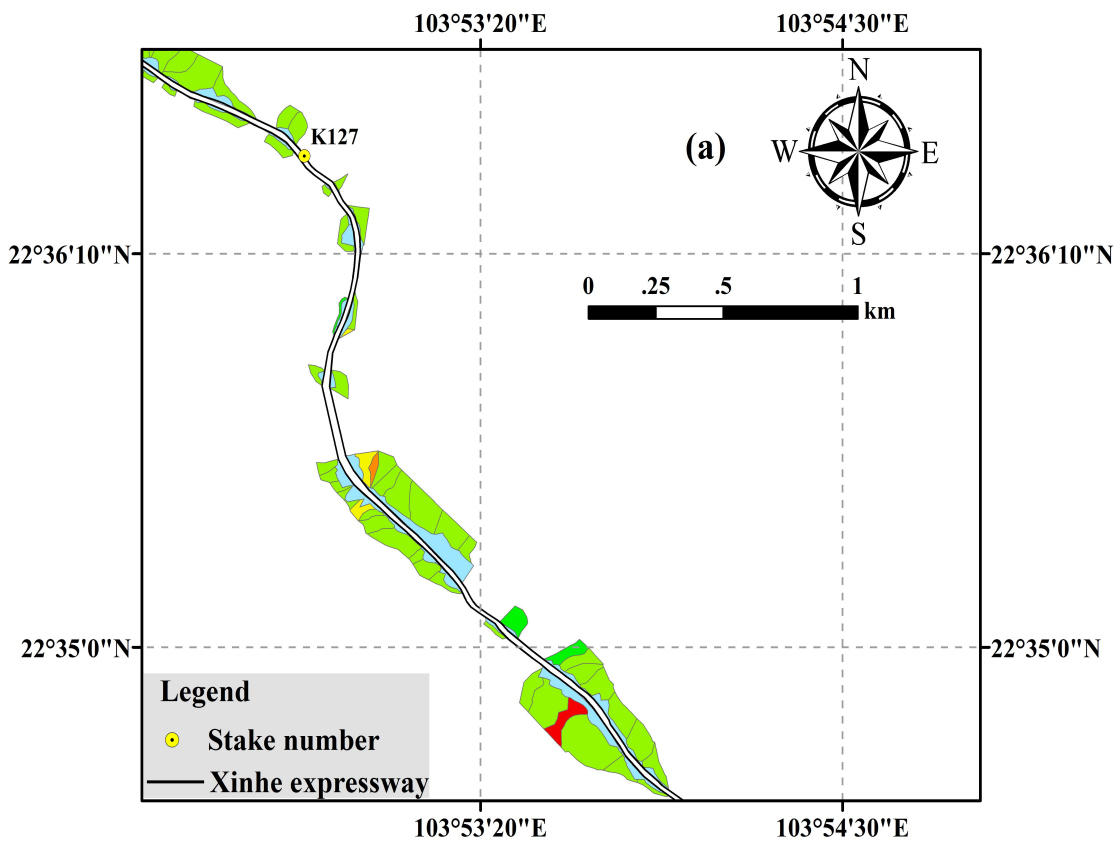

Figure 7(a). The subgraph of Figure 7 with zoomed sections.

Comment 24: Line 352 incorrect Harvard reference

Response 24: Thank you for your comments! We have followed your advice to adjust it. Details are in following paragraph and manuscript.

The calculation method of the *K* value was adopted by Formula 4 to obtain the soil erodibility factor values of each slope (Sharply and Williams 1990), as shown in Tables 3 and 4.

Comment 25: Table 3 and 4. Are these necessary for the main body of your text? I suggest these should be supplementary material/appendices.

Response 25: We are in complete agreement with your comment. We take the Table 3 and 4 as the supplementary material/appendices.

Comment 26: Equation 6 some issue with font/layout. Not possible to understand currently.

Response 26: Thank you for your comments! We have followed your advice to revised it. Details are in following paragraph and manuscript.

$$\lambda = flowacc \cdot cellsize \qquad (6)$$

Comment 27: Section 3.2.5 state what remote sensing imagery and method was used.

Response 27: Thank you for your comments! We have followed your advice to explain and revise it. Details are in the following paragraph and manuscript.

The remote sensing images used in this study were derived from 8m hyperspectral images produced by GF-1 satellite (http://www.rscloudmart.com/).
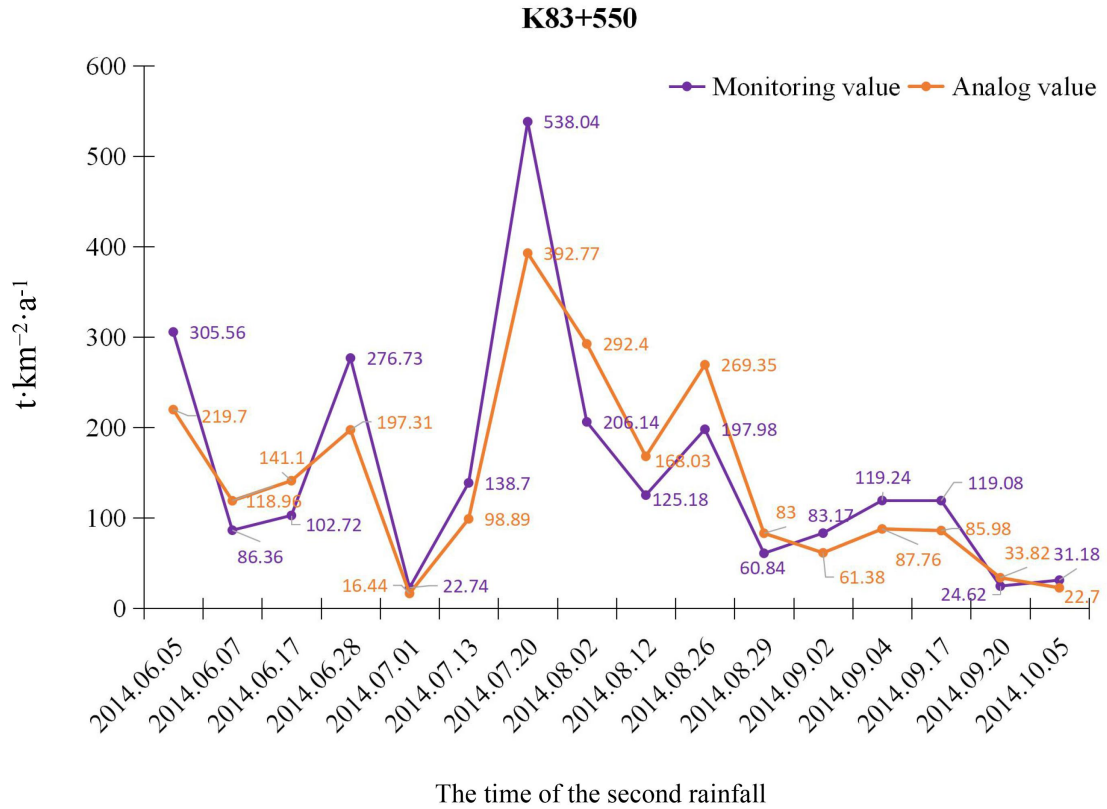
Method:

Vegetation coverage and management factor (*C*): *C* is defined as the ratio of soil loss from land cropped under specific conditions to the corresponding loss from clean-tilled, continuous fallow. Taking full advantage of the Normalized Difference Vegetation Index (NDVI) data, *C* is calculated according to the equation of Gutman and Ignatov (1998).

$$C = 1 - \frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}}$$

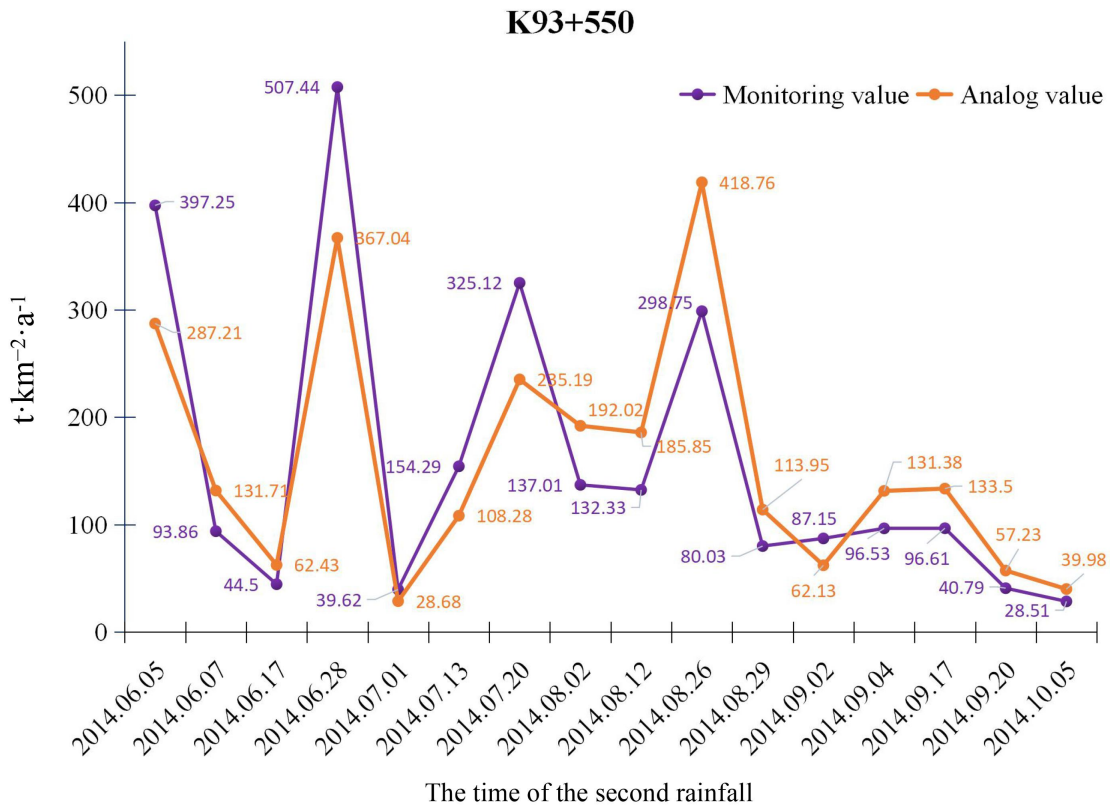**Comment 28:** Table 9 convert to a figure. It is hard to quickly look at a table and spot trends/differences.

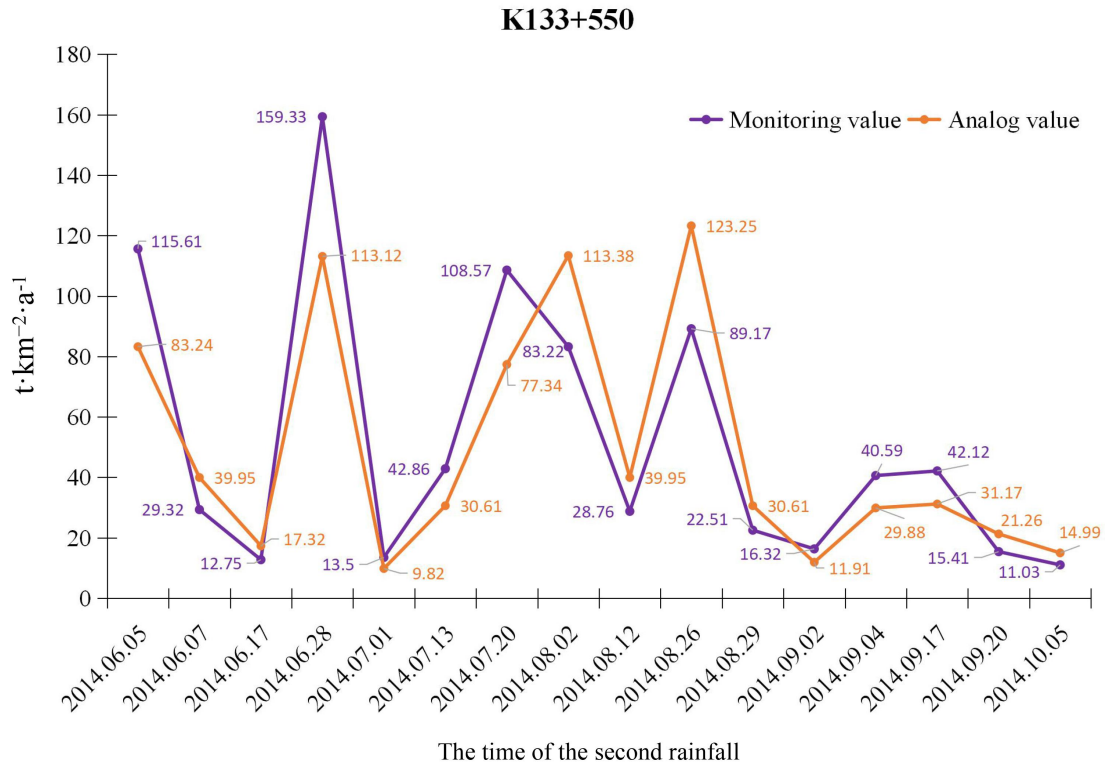**Response 28:** Thank you for your comments! We have followed your advice to revise it. Details are in the following paragraph and manuscript.

Figure 9. Comparison of model prediction and monitoring results (K83+550)

Figure 10. Comparison of model prediction and monitoring results (K93+550)

Figure 11. Comparison of model prediction and monitoring results (K133+550)

Comment 29: Tables 10-12. There are too many tables in this paper. Consider moving to supplementary material, summarising or converting to a figure.

Response 29: We are in complete agreement with your comment. So, we have followed your advise to adjust it. We take the Table 10-12 as the supplementary material/appendices. Details are in the manuscript.

Comment 30: This work presents an interesting case study, which clearly required much research to be undertaken. It is still not clear how transferrable this would be to other settings, or what the value of the work is beyond this case study. In the discussion, try to emphasise the bigger picture in terms of how others can now build upon your research.

Response 30: We greatly appreciate your valuable suggestion concerning improvement to this paper. We have followed your advice to revised it. We have added some content (**Discussion**), hoping to meet the requirements of the reviewer. Details are in following paragraph and manuscript.

Slope is the main part of soil and water loss caused by highways. So, it is very important to predict and early warning. The highway slope is divided into natural slope and engineering (artificial) slope. The RUSLE model is used to predict the soil erosion of natural slope, on the premise of not considering the variation in rainfall erosivity, it is found that in the same type area, the method of model parameters acquisition are basically consistent through the literature analysis

and comparison (Yang 1999; Yang 2002; Peng et al., 2007; Zhao et al., 2007; Chen et al., 2014; Zhu et al., 2016), after comparing the monitoring data onto runoff plots, it is found that the error between the predicted value and the monitoring value calculated by the RUSLE model is small (Yang 1999; Yang 2002; Li et al., 2004), it shows that the prediction results of the model are reliable. In the prediction of slope erosion of engineering (artificial), the previous study mainly considered the disturbance to the surface during the construction process (He 2004; Liu et al., 2011; He 2008; Hu, 2016; Zhang et al., 2016; Song et al., 2007), and do not consider the soil erosion resulting from the construction of the engineering slope; In the process of predicting soil and water loss in engineering slope by using RUSLE model, the correction of the conservation support practice factor (such as cement block, hexagonal brick, etc.) will often be ignored (Zhang 2011; Morschel et al., 2004; Correa and Cruz 2010); In addition, most of the cases using RUSLE model to predict soil erosion of highway slopes, in the use of remote sensing, it is usually based on grid data, but lack of consideration for catchment units (IsIam et al., 2018; Villarreal et al., 2016; Wu and Yan 2014; Chen et al., 2010).

Therefore, this study analysis the characteristics of soil erosion in the process of expressway construction, and improves the following aspects on the basis of previous research: (1) In order to be closer to the actual situation, we divide the highway slope into natural unit and artificial unit, and calculate the amount of soil loss from the slope surface to the pavement by the slope surface catchment unit, which is more in line with the actual situation, and this idea can be popularized; (2) We consider the spatial heterogeneity of linear engineering of expressway, then the rainfall factor is spatially interpolated, it has made up for the defects of rainfall data usually used by rainfall stations in previous studies. (3) We modify the parameters of the artificial slope by means of actual survey, runoff plot observation and other means, and the parameters of the artificial slope are corrected by referring to the form of the project and the materials used.

Reference:

Yang, Z. S.: Study on Soil Loss Equation of Cultivated Slopeland in Northeast Mountain Region of Yunnan Province. Bulletin of Soil and Water Conservation, (1): 1-9, 1999 (in Chinese).

Peng, J., Li, D. D., Zhang, Y. Q.: Analysis of Spatial Characteristics of Soil Erosion in Mountain Areas of Northwestern Yunnan Based on GIS and RUSLE. Journal of mountain science, 25(5): 548-556, 2007 (in Chinese).

Zhu, J., Li, Y. M., Jiang, D. M.: A Study on Soil Erosion in Alpine and Gorge Region Based on GIS and RUSLE Model-Taking Lushui County of Yunnan Province as an Example. Bulletin of Soil and Water Conservation, 36(3): 277-283, 2016 (in Chinese).

Yang, Z. S.: Study on Soil Loss Equation in Jinsha River Basin of Yunnan Province. Journal of mountain science, 20: 3-11, 2002 (in Chinese).

Chen, S. X., Yang, X. H., Xiao, L. L., Cai, Y. H.: Study of Soil Erosion in the Southern Hillside Area of China Based on RUSLE Model. Resources Science, 36(6): 1288-1297, 2014 (in Chinese).

Zhao, L., Yuan, G. L., Zhang, Y., He, B., Liu, Z. H., Wang, Z. Y., Li, J.: The Amount of Soil Erosion in Baoxiang Watershed of Dianchi Lake Based on GIS and USLE. Bulletin of So il

and Water Conservation, 27(3): 42-46, 2007 (in Chinese).

Li, J. G., Dao, H. Y., Zhang, L., Zhang, H. K.: Soil and Water Loss Monitoring in the Dianchi Watershed. Research of Soil and Water Conservation, 11(2): 75-77, 2004 (in Chinese).

Liu, S. L., Zhang, Z. L., Zhao, Q. H., Deng, L., Dong, S. K.: Effects of Road on Landscape Pattern and Soil Erosion: A Case Study of Fengqing County, Southwest China. Chinese Journal of Soil Science, 42(1): 169-173, 2011 (in Chinese).

He, F.: Prediction of soil erosion in foundation slope of South Hubei Road Based on RUSLE. Beijing Normal University, 2008 (in Chinese).

Hu, L.: Study on development and mechanism of water Erosion and Ecological water erosion control technology of Highway slope in Cold Region. Xi'an University of technology, 2016 (in Chinese).

He, X. W.: Study on prediction of soil erosion in Road area. Beijing Normal University, 2004 (in Chinese).

Zhang, T., Jin, D. G., Dong, G. C., Lin, J., Tang, P., Li, L. P.: Monitoring Soil Erosion in Linear Production and Construction Project Areas Based on RUSLE-A Case Study of North Ring Expressway in Ningbo City, Zhejiang Province. Bulletin of Soil and Water Conservation, 36(5): 131-135, 2016 (in Chinese).

Song, X. Q., Zhang, C. Y., Liu, J.: Formation of Soil and Water Loss and Its Characteristics in Development and Construction Projects. Bulletin of Soil and Water Conservation, 27(5): 108-113, 2007 (in Chinese).

Zhang, D. S.: The calculation of urban soil erosion based on GIS-a case study of Wuhan City. Southwest University of M.S.Dissertation, 2011 (in Chinese).

Morschel, J., Fox, D. M., & Bruno, J. F.: Limiting sediment deposition on roadways: topographic controls on vulnerable roads and cost analysis of planting grass buffer strips. Environmental Science & Policy, 7(1): 39-45, 2004.

Correa, C. M. C., Cruz, J.: Real and estimative erosion through RUSLE from forest roads in undulated at heavily undulated relief. Revista Árvore, 34(4): 587-595, 2010.

Islam, M. R., Wan, Z. W. J., Lai, S. H., Osman, N., Din, M. A. M., Zuki, F. M.: Soil erosion assessment on hillslope of GCE using RUSLE model. Journal of Earth System Science, 127(4): 50, 2018.

Villarreal, M. L., Webb, R. H., Norman, L. M., Psillas, J. L., Rosenberg, A. S., Carmichael, S.: Modeling landscape-scale erosion potential related to vehicle disturbances along the USA-Mexico border. Land Degradation & Development, 27(4): 1106-1121, 2016.

Response to Decision Letter

Dear Dr. Paolo Tarolli and referee,

We are very pleased to learn from your letter about revision for our manuscript which entitled *"Dangerous degree forecast of soil and water loss on highway slopes in mountainous areas using RUSLE model".*

We greatly appreciate reviewer's thoughtful suggestions concerning improvement to our paper. These comments are all valuable and very helpful for revising and improving our paper, as well as the important guiding significance to our researches.

Thank you for your consideration!

Sincerely yours,

*Corresponding Author: Shi Qi

P.S.

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Response to review's comments for nhess-2017-406-RC1

Reviewer's #1 comments:e

Comment 1: The manuscript has been improved. However, it's regretful that most of my advices have not been accepted. I think a major revision may be needed.

Response 1: First of all, all the authors thank you for your affirmation of the last revision, though it still needs some improvement. We hope that this revision will meet your requirements!

Comment 2: Most of my advices have been neglected although the authors have written a very long response, e.g., Responses 12, 13, 15, 19, 21, 22.

Response 2: Thank you for your patience and careful work! We will further improve and modify these response according to your comments. Details are in following paragraph and manuscript.

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Comment 12: Line 78: What's the meaning of the following sentence: "...have explored the process of using the RUSLE model"?

Response 12*: Thank you for your comments! We have revised this sentence again, hoping to express it more clearly. Details are in following paragraph and manuscript.

Moreover, many scholars have made many useful explorations in modifying the model parameter values and improving the simulation accuracy.

Comment 13: Lines 81-82: I am lost.

Response 13*: We have revised this sentence again, hoping to express it more clearly. Details are in following paragraph and manuscript.

Tresch S et al (1995) thought that the topographical factor LS are one of the main factors for soil erosion modelling approaches within the RUSLE environment. There exists a large variety of different S-factors, for the most used soil erosion modelling environment, which have highly significant influences on the calculated erosion values.

Revised:

Tresch et al. (1995) believed that the slope length (L) or slope steepness factor (S) is one of the main factor for soil erosion prediction, and significantly influence the erosion values calculated by the RUSLE.

Comment 15: Lines 125-126: I cannot understand.

Response 15*: Thank you for your comments! We have revised this sentence again, hoping to express it more clearly. Details are in following paragraph and manuscript.

However, the accumulation degree of soil and water loss in highways cannot satisfy the requirements of model development (Xu et al., 2009; Bakr et al., 2012). To date, no mature model of soil erosion in highways is available.

Revised:

However, the research progress on soil and water loss of highway hardly meet the requirements of the practical work. (Xu et al., 2009; Bakr et al., 2012). So far, we still need to do a lot of work on the prediction of soil erosion in highway slopes.

Comment 19: Study area. Line 193: Figure 1 may be merged to Figure 4 in page 11.

Response 19: Thank you for your comments! According to your comments, we explained it, details are in following paragraph.

Figure 1 refers to the overview of the study region, figure 4 refers to the division results of prediction units. After all the authors discuss, we believed that these two graphs express independent content, and the content expressed in Figure 4 is not closely related to chapter 2 (Study area). So, our final decision is not to merge Figure 1 to Figure 4.

Comment 20: Results and analysis. From page 9 to page 22: The part looks like a scientific report instead of a research paper. Except the original experimental data, hardly any in-depth discussion exists. Page 23: The calculated results have not been compared with the results described in other references. Also I do not know why the errors emerge. Especially, I hope to emphasize that a comparison of the results with other references and a discussion in depth may be added in the manuscript, otherwise the manuscript will not look like a scientific paper.

Response 20: We greatly appreciate your valuable suggestion concerning improvement to this paper. We have followed your advice to revised it. We have added some content (**Discussion**), hoping to meet the requirements of the reviewer. Details are in following paragraph and

manuscript.

Discussion

Slope is the main part of soil and water loss caused by highways. So, it is very important to predict and early warning. The highway slope is divided into natural slope and engineering (artificial) slope. The RUSLE model is used to predict the soil erosion of natural slope, on the premise of not considering the variation in rainfall erosivity, it is found that in the same type area, the method of model parameters acquisition are basically consistent through the literature analysis and comparison (Yang 1999; Yang 2002; Peng et al., 2007; Zhao et al., 2007; Chen et al., 2014; Zhu et al., 2016), after comparing the monitoring data onto runoff plots, it is found that the error between the predicted value and the monitoring value calculated by the RUSLE model is small (Yang 1999; Yang 2002; Li et al., 2004), it shows that the prediction results of the model are reliable. In the prediction of slope erosion of engineering (artificial), the previous study mainly considered the disturbance to the surface during the construction process (He 2004; Liu et al., 2011; He 2008; Hu, 2016; Zhang et al., 2016; Song et al., 2007), and do not consider the soil erosion resulting from the construction of the engineering slope; In the process of predicting soil and water loss in engineering slope by using RUSLE model, the correction of the conservation support practice factor (such as cement block, hexagonal brick, etc.) will often be ignored (Zhang 2011; Morschel et al., 2004; Correa and Cruz 2010)；In addition, most of the cases using RUSLE model to predict soil erosion of highway slopes, in the use of remote sensing, it is usually based on grid data, but lack of consideration for catchment units (IsIam et al., 2018; Villarreal et al., 2016; Wu and Yan 2014; Chen et al., 2010).

Therefore, this study analysis the characteristics of soil erosion in the process of expressway construction, and improves the following aspects on the basis of previous research: (1) In order to be closer to the actual situation, we divide the highway slope into natural unit and artificial unit, and calculate the amount of soil loss from the slope surface to the pavement by the slope surface catchment unit, which is more in line with the actual situation, and this idea can be popularized; (2) We consider the spatial heterogeneity of linear engineering of expressway, then the rainfall factor is spatially interpolated, it has made up for the defects of rainfall data usually used by rainfall stations in previous studies. (3) We modify the parameters of the artificial slope by means of actual survey, runoff plot observation and other means, and the parameters of the artificial slope are corrected by referring to the form of the project and the materials used.

Reference:

Yang, Z. S.: Study on Soil Loss Equation of Cultivated Slopeland in Northeast Mountain Region of Yunnan Province. Bulletin of Soil and Water Conservation, (1): 1-9, 1999 (in Chinese).

Peng, J., Li, D. D., Zhang, Y. Q.: Analysis of Spatial Characteristics of Soil Erosion in Mountain Areas of Northwestern Yunnan Based on GIS and RUSLE. Journal of mountain science, 25(5): 548-556, 2007 (in Chinese).

Zhu, J., Li, Y. M., Jiang, D. M.: A Study on Soil Erosion in Alpine and Gorge Region Based on GIS and RUSLE Model-Taking Lushui County of Yunnan Province as an Example. Bulletin

of Soil and Water Conservation, 36(3): 277-283, 2016 (in Chinese).

Yang, Z. S.: Study on Soil Loss Equation in Jinsha River Basin of Yunnan Province. Journal of mountain science, 20: 3-11, 2002 (in Chinese).

Chen, S. X., Yang, X. H., Xiao, L. L., Cai, Y. H.: Study of Soil Erosion in the Southern Hillside Area of China Based on RUSLE Model. Resources Science, 36(6): 1288-1297, 2014 (in Chinese).

Zhao, L., Yuan, G. L., Zhang, Y., He, B., Liu, Z. H., Wang, Z. Y., Li, J.: The Amount of Soil Erosion in Baoxiang Watershed of Dianchi Lake Based on GIS and USLE. Bulletin of So il and Water Conservation, 27(3): 42-46, 2007 (in Chinese).

Li, J. G., Dao, H. Y., Zhang, L., Zhang, H. K.: Soil and Water Loss Monitoring in the Dianchi Watershed. Research of Soil and Water Conservation, 11(2): 75-77, 2004 (in Chinese).

Liu, S. L., Zhang, Z. L., Zhao, Q. H., Deng, L., Dong, S. K.: Effects of Road on Landscape Pattern and Soil Erosion: A Case Study of Fengqing County, Southwest China. Chinese Journal of Soil Science, 42(1): 169-173, 2011 (in Chinese).

He, F.: Prediction of soil erosion in foundation slope of South Hubei Road Based on RUSLE. Beijing Normal University, 2008 (in Chinese).

Hu, L.: Study on development and mechanism of water Erosion and Ecological water erosion control technology of Highway slope in Cold Region. Xi'an University of technology, 2016 (in Chinese).

He, X. W.: Study on prediction of soil erosion in Road area. Beijing Normal University, 2004 (in Chinese).

Zhang, T., Jin, D. G., Dong, G. C., Lin, J., Tang, P., Li, L. P.: Monitoring Soil Erosion in Linear Production and Construction Project Areas Based on RUSLE-A Case Study of North Ring Expressway in Ningbo City, Zhejiang Province. Bulletin of Soil and Water Conservation, 36(5): 131-135, 2016 (in Chinese).

Song, X. Q., Zhang, C. Y., Liu, J.: Formation of Soil and Water Loss and Its Characteristics in Development and Construction Projects. Bulletin of Soil and Water Conservation, 27(5): 108-113, 2007 (in Chinese).

Zhang, D. S.: The calculation of urban soil erosion based on GIS-a case study of Wuhan City. Southwest University of M.S.Dissertation, 2011 (in Chinese).

Morschel, J., Fox, D. M., & Bruno, J. F.: Limiting sediment deposition on roadways: topographic controls on vulnerable roads and cost analysis of planting grass buffer strips. Environmental Science & Policy, 7(1): 39-45, 2004.

Correa, C. M. C., Cruz, J.: Real and estimative erosion through RUSLE from forest roads in undulated at heavily undulated relief. Revista Árvore, 34(4): 587-595, 2010.

Islam, M. R., Wan, Z. W. J., Lai, S. H., Osman, N., Din, M. A. M., Zuki, F. M.: Soil erosion assessment on hillslope of GCE using RUSLE model. Journal of Earth System Science, 127(4): 50, 2018.

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Comment 4: I still do not think the Revised Universal Soil Loss Equation (RUSLE) is suitable for the gully erosion although the authors have given an explanation in Response 9. The gully erosion with mass failures is different to the water erosion on the gentle slope.

Response 4: Thank you for your comment! We agree with your comment after discussing and consulting the references.

After careful checking, we think that the relevant parts of the manuscript is independent of the RUSLE model. Therefore, it is incompatible with the core idea of this paragraph. So, we decided to delete this sentence for the sake of the accuracy of the manuscript.

Comment 5: In Response 29, now that you have agreed to my advice, why do not you revise the manuscript according to my comment? Besides, is the reference list referred in Response 27 up to the demand of the journal?

Response 5: Thank you for your comments! We have revised it again, details are in following paragraph and manuscript.

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Comment 29: Page30: "Wang, H. J., Yang, Y., and Wang, W. J.: Prediction of Soil Loss Quantity...": Is it a paper in Chinese journal?

Response 29*: We have revised this sentence again, hoping to express it more clearly. Details are in following paragraph and manuscript.

Wang, H. J., Yang, Y., and Wang, W. J.: Prediction of Soil Loss Quantity on Side Slope of Freeway Construction: Amendments to Main Parameters of USLE. Journal of Wuhan University of Technology (Transporatation Science & Engineering), 29(1):12-15, 2005 (in Chinese).

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Comment 6: Besides, is the reference list referred in Response 27 up to the demand of the journal?

Response 6: We have revised this reference, details are in following paragraph and manuscript.

Liu, X. Y.: Study on the slope stability and its rheological influence in Mountain highway. Central South University, 2013 (in Chinese).

Comment 7: There are so many language errors in the revised version shown in the authors' response. It is not imaginable that the last sentences in responses 18 and 26 have been polished by a scientist whose native language is English.

Response 7: Thank you for your instructive suggestions. According to your helpful advice, we have rewritten these responses. Details are in the paragraph and manuscript. Thank you again!

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Comment 18: Lines 161-162: I am lost.

Response 18: Thank you for your comments! We have revised this sentence again, hoping to

express it more clearly. Details are in following paragraph and manuscript.

This study scientifically not only predicts the amount of soil erosion caused by highway construction in mountain areas for the rational layout of facilities, which reduces damage to the original topography and effectively prevents and controls new soil erosion, but also provides scientific and technical bases and reference methods.

Revised:

This study not only scientifically predicts the amount of soil erosion caused by the highway construction in mountain areas, but also provides a scientific basis for the prevention and control of soil erosion, and the rational allocation of prevention and control measures.

Comment 26: Line 4 of page 28: "A cement box should be added in the soil a year": Is this the only conservation practice we should adopt?

Response 26: Thank you for your comments! According to your comments, we explained it. Details are in following paragraph.

Some other conservation practices: The technology of mortar rubble retaining wall and retaining wall (slope); the technology of honeycomb mesh grass protection; the technology of hydraulic seeding grass protection.

Revised:

Some other conservation practices: Technology of masonry retaining wall; Technology of honeycomb grid revetment protection; Technology of hydraulic seeding grass protection.

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