Adam Wei
editor
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Ref. " Trends of streamflow, sediment load and their dynamic relations for the catchments in the middle reaches of the Yellow River in the past five decades" by Gao et al.(HESS-2012-157), for special issue "Water, Climate, and Vegetation: ecohydrology in a changing world".

Dear Professor Wei,

Thanks for the constructive comments of 14 May 2012, 23 May 2012 and 22 June 2012 regarding the above manuscript. I have answered the comments one by one and therefore revised the manuscript accordantly.

I hope the one by one answer will satisfy three referees.

Yours sincerely

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For the comments of anonymous Referee #1 in May 14,2012:

P5489 ln6. Replace" adopted" with "implemented"

Answer: We have replaced the "adopted" with "implemented" in Ln6, P5489. The words in Ln5-7 P5489 read now:

"To control the severe soil erosion, a number of soil conservation measures have been implemented on the Loess Plateau since the 1950s (Ye et al., 1994; Zhang et al., 1998; Ran et al., 2000), which mainly include afforestation, pasture reestablishment, terracing and sediment trapping dams."

P5489 ln 7, Delete "consequent"

Answer: We have deleted "consequent" in Ln7, P5489, and also "land use and land cover change" was abbreviated to "LUCC". The words in Ln7-9 P5489 were rewritten to the following sentence:

"The measures resulted in great land use and land cover changes (LUCC) and dramatically altered hydrological regimes and significantly reduced sediment load in the Yellow River."

P5489 ln11, Replace "their dynamic relations" with "the relationships between streamflow and sediment load"

Answer: We have replaced "their dynamic relations" with "the relationship between streamflow and sediment load" in Ln11, P5489. And the words in Ln10-11 P5489 read now:

"But, it is not very clear how the soil conservation measures affect the relationships between streamflow and sediment load in a catchment."

The words were organized and moved to 2rd paragraph in P5490 as 2nd sentence of the revised manuscript.

P5490 ln 1-3, Please reword "the relation between streamflow and sediment load did not change essentially in the research of Pan et al. (1999) at a regional scale and even Zheng and Cai (2007) in the small paired catchments."

Answer: We organized the words in this section and words in Ln1-5 P5490 read now:

"Rustomji et al. (2008) showed that mean annual sediment concentration in 7 of 11 catchments exhibited a statistically significant decreasing trend over time. A few researches focused on the relationship between streamflow and sediment load. However, the results were inconsistent and complex. Zheng and Cai (2007) concluded that increasing vegetation coverage didn't change the relationship between streamflow and sediment load in the paired catchments. But a different conclusion was drawn from Liu et al. (2010), who showed that the relationship between streamflow and sediment load changed obviously with land sue change in another paired catchments under heavy rainfall and high rainfall intensity. Rustomji et al. (2008) showed that although the results from the sediment rating curves based on the daily data support the conclusion of the variations of annual suspended sediment concentration, the soil conservation measures seemly did not significantly change the sediment rating curves in two years with the similar precipitation in two catchments on the Loess Plateau. Pan et al. (1999) indicated that the relationship between streamflow and sediment load in flood season did not change essentially in a regional with area of 11×10^4 km^2 on the Loess Plateau."

P5492 ln 3. What do you mean by "two elements"?

Answer: "two elements" here means "streamflow and sediment load". To make it clear, the words in ln2-5 P5492 read now:

"To reduce the effects of precipitation and drainage area on the analysis of streamflow and sediment load for the catchments of different size, the volumes of annual/ monthly streamflow and sediment load are standardized by the controlling area and the precipitation in corresponding time."

P5492 ln 6, I am not sure about the unit for streamflow and it is essentially dimensionless.

Answer: Agree with the reviewer. After the standardization of total streamflow volume with the precipitation over a certain area and time, the unit for streamflow is dimensionless and actually 1000 times the "runoff coefficient". The words in L5-8 P5492 read now:

"So a unit for streamflow is "$m^3.km^{-2}.mm^{-1}$", which is dimensionless, the value is 1000 times the runoff coefficient and means the runoff availability (m^3) per km^2 area per mm precipitation in a catchment in a given period. And a unit for sediment load, "$t.km^{-2}.mm^{-1}$", actually signifies sediment availability (t) per km^2 area per mm precipitation in each catchment in a given period."

P5495 ln 4, what is the significance level?

Answer: Table 3 showed that except the two loess hilly-gully catchments, the standardized annual streamflow in the five catchments presented negative trends at a statistically significance level by Mann-Kendall test, in which four catchments had the level with $p < 0.001$, and one is with $p < 0.05$. The words in L3-5 P5495 read now:

"Annual streamflow (with unit of $m^3.km^{-2}.mm^{-1}$) in the five catchments except the two loess hilly-gully catchments presented negative trends by Mann-Kendall test with statistically significance level, in which four catchments were detected at $p < 0.001$ and one at $p < 0.05$ (Fig.2, Table 3)"

P5495 ln 5, Can you express the rate of streamflow change as mm/year/year?

Answer: The change rate of streamflow was represented as "$m^3.km^{-2}.mm^{-1}.a^{-1}$" in the text. The unit came from the standardization of annual streamflow volume with the precipitation over a certain area and in one year. The words in Ln5-8, P5495 read now:

"Average change rate of annual streamflow was -3.39 per year in the three transition zone catchments, but only -0.67 per year in the two rocky mountain catchments."

P5495 ln 15, Delete "Cleary, years for the former were all earlier than those for the latter"

Answer: Now the sentence in Ln15-16, P5495 was deleted in the place.

P5495 ln 18. Can you provide any references to support your argument?

Answer: A few references, such as Ran et al (2000), Yao et al (2004), Xu and Sun (2006) gave the examples of the effects of cumulative area and the allocation of the main types of soil conservation measures on the runoff trend and sediment reduction in catchments on the Loess Plateau. From their researches we could get some important information about the cumulative area of soil and water conservation and their allocation in a catchment which affected the hydrologic cycle and sediment reduction.

The words in L16-20 P5495 now read:

"Results from Ran et al. (2000), Yao et al. (2004) and Xu and Sun (2006) implied that such a percentage of the area for soil conservation measures can significantly affect hydrological recycling and sediment retention or transportation in a catchment".

So two references were added in the reference list of the paper as following:

Xu, J.X and Sun, J.: Threshold phenomenon of sediment reduction beneficial from soil-water conservation measures in the Wudinghe river, Advances in Water Science, 17(5): 610-615, 2006 (in Chinese).

Yao, W.Y., Ru, Y.y., Kang, L.L.: Effect of flood retention and sediment reduction with different allocation system of water and soil conservation measures. J. Soil Water Conserv.. 18(2): 28-31, 2004 (in Chinese).

P5495 ln22, Delete "sequential"

Answer: Thanks for the reminding. We deleted "sequential" in the sentence. And the words in L21-28 P5495 were organized and read now:

"According to the change points for the five catchments and in consideration of the implementation of "Grain for Green" project after 1999, the whole time period for streamflow data is divided into three periods: period 1 (pre-change point year period, abbreviated to P1), period 2 (post-change period from pre-change point year to 1999, P2), and period 3 ("Grain for Green" period from 2000 to 2005, P3). Monthly flow duration curves were derived and relative changes of streamflow at high(5%), median(50%) and low(95%) percentiles in P2 and P3 are listed in Table 4, as compared to P1."

P5496 ln 2-4, Reword.

Answer: The words in ln1-4 P5496 were organized and read now:

"From Table 4, relative changes of streamflow were negative except for the two loess hilly-gully catchments, i.e. Qinjian and Yanhe catchments. Change degrees, whenever in P2 or P3, were higher in the three transition zone catchments than those in the two rocky mountain catchments."

P5496 ln 5, what do you mean by "change extent"?

P5496 ln 9, should be high, median, and low percentile flows.

Answer: We mean the change degree here. We replaced "change extents" in Ln5 P5496 with "change degrees" in the sentence. The words in Ln5-14 P5496 read now:

"Change degrees of streamflow in the transition zone catchments were not only greater in P3 than those in P2, but also much greater than those in the rocky mountain catchments in P3. Average relative changes for the three transition zone catchments in P3 reached 72.5%, 58.4%, and 57.3% at the high(5%), median(50%), and low(95%) percentile flows, respectively. Moreover, average relative changes for the two rocky mountain catchments in P3 were 46.1%, 48.3%, and 50.4% at the same percentiles, respectively. That means that the implementation of soil conservation measures exerted greater effects on the transition zone catchments than the rocky mountain catchments, especially in P3 when the "Grain for Green" project was implemented."

Ln15-17 P5496 is rewritten also as following:

"Change degrees were much weaker for the two loess hilly-gully catchments, i.e. Qinjian and Yanhe catchments. The result is consistent with the trend detection for the five catchments."

P5497 ln 3-5, Reword

Answer: The words in Ln3-5 P5497 read now:

"To investigate relative changes in annual sediment load in all the seven catchments, the three periods are identified for the sediment load data using the same period division criteria as those for annual streamflow (Table 6)."

P5497 ln 25, How did you use the change points to analyse the dynamic relationships?

Answer: When we analyzed and compared the relationship trend of streamflow and sediment load, the periods were defined referring to the change point of sediment load detected with Pettitt test in each catchment. The words in Ln25-28 P5497 read now:

"Change points of annual sediment load in the seven catchments (Table 5) are referred to identify the periods and analyze the dynamic relations of streamflow to sediment load. Figure 3 shows a set of scatter diagrams illustrating the relationship between monthly sediment load and monthly streamflow in the three periods in the seven catchments, with simple linear regression equations presented simultaneously."

P5498 ln1, Why did not you include the rest of month? No data?

Answer: We used the data in the flood season from May to October to analyze the relationships of streamflow and sediment load here because of the data limitation of the other months.

The words in Ln 1-2 P5498 read now:

"Because no data were recorded in some months in some of the catchments, the monthly data of sediment load and streamflow in the flood seasons from May to October were used in the study, so as to make the results comparable."

P5498 ln3-6, Poor correlations between streamflow and sediment load would suggest variable sediment concentrations? The authors should elaborate on this and explain how poor correlations were result from human activities. Also any physical basis for the form of relationships shown in Figure 2?

Answer: Agree with the reviewer's comments. Figure 2 (after revision figure 3 now) is plotted to express the relationships between monthly streamflow and monthly sediment load in the flood season. Poor correlations suggest variable sediment concentration and that the phenomena of high streamflow- low sediment load and low streamflow- high sediment load exist in the catchments at the monthly scale. It closely relates to the characteristics of human activities on the Loess Plateau. We give more explanation of how poor correlations result from the human activities. The words in L3-6 P5498 are reworded as following and were moved to the place after ln21 P5499.

"Compared to P1, the relationship between streamflow and sediment load generally became poor in the correlative coefficients from P2 to P3, especially in the transition zone catchments as well as Shiwang catchment, one of the rocky mountain catchments (Fig. 2b,c and g). On the Loess Plateau, human activities are recognized as the primary factor leading to the negative trends of streamflow and sediment load (Ran et al., 2000; Fu et al., 2004; Rustomji et al., 2008; Yao et al., 2010). But human activities are wide ranging and some of them can potentially increase soil loss in the catchments (Ran et al., 2000; Wang and Fan,2002).

The implementation of soil and water conservation was expected to control soil erosion and reduce sediment delivery to the Yellow River (Morgan 1986; Chen et al., 1988). The "Grain for Green" project implemented since 1999 resulted in a considerable improvement of vegetation coverage on the Loess Plateau. However the sediment trapping dams built up in the 1970s and 1980s were easily damaged by heavy rainstorm (Zhang, 1995). The ratio of silted storage to the total storage of reservoir was up to 40% in the seven catchments (Xiong and Ding, 1994). The variability of sediment concentration in the catchments in P2 was closely related to the ruined sediment trapping dams and the release regime of reservoirs (Zhang, 1995; Ran et al., 2000). Moreover, rapid urbanization and extensive infrastructure construction were simultaneously proceeding in the region (Liu and Han, 2007), which usually produced a huge amount of sediment deposition and dreg on the river bed and probably led to a high concentration flow, even in a medium rain event (Xu, 2002)."

For above description, the following references are added in the reference list:

Fu G.B., Chen S.L., Liu C.M., Shepard D.: Hydro-climate trends of the Yellow River Basin for the last 50 years. Climatic Change, 65:149-178,2004.

Xiong G.S and Ding L.Y.: The survey report of sediment deposition in the reservoirs of Yellow River Basin, Yellow River Conservation Commission, Zhengzhou, Rep., 2004 (in Chinese).

Zhang S.L.: Investigation of the influence of the flood occurred in August 1994 on flow and sediment yield in Wuding River Basin, Yellow River, 5: 24-27,1995 (in Chinese).

Liu C.X. and Han L.B.: Review of researches in vegetation restoration of freeway slopes. Acta Ecol. Sin., 27(5):2090-2908,2007 (in Chinese).

Yao W.Y., Xu J.H. and Ran D.C.(Eds): Analysis and evaluation of the water sand changing regime in catchments of Yellow River Basin. Yellow River Water Conservancy Press, Zhengzhou, 2010 (in Chinese).

The scattered distribution of streamflow and sediment load was based on the monthly scale. Although the monthly data couldn't reveal the important event based detail, the form of relationships in figure 2 (after revision figure3) is still related to the characteristics in fluid mechanics of hyperconcentrated flow frequently occurred on the Loess Plateau.

P5498, ln7-10, Replace "domain" with "range".

Answer: The words in Ln7-10 rewritten to following and also words to explain influencing factors were added based on the comments of referee 3:

"The range of the scattered distributions of monthly sediment load against monthly streamflow in the three transition zone catchments is up to {2000,1000}, whereas in the two rocky mountain catchments, only {500,100}. Apparently, the former is much wider than the latter. The range of the scattered distribution in the two loess hilly-gully catchments lies in the middle. The factors, such as frequency of rainstorm, vegetation coverage, soil and hydrological geology were supposed to determine the distribution scope of streamflow and sediment load in catchments (Ran et al., 2000)"

P5498, ln24-27, Do you mean the soil conservation measures implemented in the 1970s to 1980s reduced the sediment generation capacity in most of the catchments?

Answer: The trend analysis showed that in the most catchments the decreasing trends of sediment load are much greater than that of streamflow. Compared to the period 1, the linear regression coefficients in the period 2 for all the catchments showed a decreasing trend ranging from -40.9% to -7.6%, the average is

-22.4% (Table 7). If the linear regression coefficient was defined as the sediment generation capacity, it was exactly decreased in the period 2.

Precipitation was sources of water in catchment, so any change of precipitation would affect the streamflow and sediment yield and transportation. However, the data of streamflow and sediment load recorded were standardized by the precipitation and the controlling area in the catchment, so the effect of precipitation and the physical feature of catchment were expected to be eliminated to some extent.

The analysis showed that most of the change points examined with the Pettitt test for the catchments are in the latter of 1970s and the beginning years of 1980s (Table 3, 5). The land use /cover change in the 1970s to 1980s was characterized with consecutive implementation of soil conservation measures. The effect of soil conservation practices on hydrological cycle aggravated and then discernible reduction in streamflow and sediment load occurred.

To make it more clearly, we re-wrote the sentence in Ln24-27 P5498 as following:

"In consideration of standardization of streamflow and sediment load data with preciptaiton and controlling area, human activities such as soil conservation measures from the 1970s to 1980s and the "Grain for Green" project after 1999 were expected to make the sediment generation capacity in the catchments to be increasingly negative trends period by period, except the two loess hilly-gully catchments (Table 7)."

P5499, ln 4-5, It is not clear to me what this means.

Answer: In this study, the regression coefficient was regarded as "sediment generation capacity" in a catchment. Apart from the regression coefficient, the absolute value of a constant in the linear regression could also indicate the amount of sediment yield in a catchment in a given streamflow volume and signify the "sediment generation capacity".

The Loess Plateau is most severely eroded area in China. Especially the water-wind erosion crisscross region on the Loess Plateau, i.e. the place where the three transition zone catchments located, is characterized with highest soil erosion and sediment delivery modulus due to both the water and wind erosion processes.

In general, soil is eroded by rainfall or wind from hill slopes and bank of gully, and stored in channel. In the flood season, the existing in-channel sediment was transported by the runoff in a rainstorm.

From the erosion processes and the transport mechanics in a catchment, the regression coefficient and the absolute value of constant in the linear regression were closely related each other and both of them could demonstrate the "sediment generation capacity" on the Loess Plaetau.

To make it more clear, the words in Ln4-5 P5499 were rewritten as following:

"From "preparation-transportation" process of soil erosion (Asselman 1999; Rovira and Batalla,2006), the absolute value of a constant (with unit of $t.km^{-2}.mm^{-1}$) in the linear regression equation for each of the catchments implies a status of existing in-channel sediment storage in a given period to some extent, which can demonstrate the "sediment generation capacity" in another way."

Two references are added in the reference list:

Asselman N.: Suspended sediment dynamics in a large drainage basin: the river Rhine, Hydrol.Process, 13, 1437-1450, 1999.

Rovira A., Batalla R.J.: Temporal distribution of suspended sediment transport in a Mediterranean basin: The Lower Tordera (NE SPAIN), Geomorpholgy, 79, 58-71,2006.

P5499, ln 4-20. The authors interpreted the constants in the regression equations as sediment storage. Is there any physical basis for the argument? What happens if they fit different functional relationships to the data?

Answer: From the equation, the absolute value of constant was the sediment volume when the streamflow was given zero. As statement in the above question and answer, soil was eroded in the processes such as rainfall splash, sheet erosion, rill erosion from the hill slope and gravitational erosion, land slide, avalanche and debris slide in the gully, and stored in the channels. During the rainstorm, the existing in-channel sediment was transported from channel to river bed. The amount of sediment was observed in a gauge station of catchment after the processes of sediment “preparation- transportation” in a hydrographic year or longer time.

The sediment “preparation- transportation” processes were affected greatly by rainfall type, LUCC and other human activities. The implementation of soil and water conservation and vegetation restoration would dramatically influence the streamflow regime and sediment “preparation- transportation” processes leading to the change of relation of streamflow and sediment load in a catchment.

Based on the physical principle of soil erosion and sediment transportation, the paper used linear regression to express the relationship on monthly scale and investigate the trend of parameters to check the effects of soil and water conservation and vegetation restoration on their relationship in catchments of the Loess Plateau.

The form of power function was used commonly to illustrate the relationship between streamflow and sediment load in the world. The form of power function was used to fit the data, and found the coefficient of determination was poorer than that of linear regression probably due to the monthly scale.

P5500, ln13. What do you mean by standard streamflow?

Answer: Thanks for reminding. It is a wrong expression. The sentence in Ln12-15 P5500 reads now:

“The impacts of soil conservation measures and the subsequent “Grain for Green” project on streamflow, sediment load, and their dynamic relations were examined for the seven catchments in the middle reaches of the Yellow River, China.”

P5501, ln 2, what do you mean by elements? Are you referring to streamflow and sediment load?

Answer: Yes, we refer “elements” in ln 2, P5501 to the streamflow, sediment load, and their relationships.

The sentence in Ln1-4 P5501 reads now:

"The effects of the LUCC on the streamflow, sediment load and their relationships were much weaker in the two loess hilly-gully catchments, probably due to the other intensive human activities."

For the comments of anonymous Referee #2 in 23 May 2012:

(1) whether the results have been published elsewhere;

Answer: The results haven't been published elsewhere. The results in this paper were obtained based on the expanded data of a master thesis in our group which have been completed last year. The master is involved here as 2nd author.

We checked the web site the reviewer mentioned, one is the following in Chinese, http://wenku.baidu.com/view/675879130b4e767f5acfce1e.html, which is the abstract in Chinese and English and the outline of the thesis.

Another is as following in English, http://www.agrpaper.com/trend-of-streamflow-sediment-load-and-their-dynamicrelation-at-watershed-in-the-middle-rea-ches-of-yellow-river-during-the-past-fivedecades.htm which is the abstract of the thesis in English.

The thesis was only uploaded to the relevant electronic system of the Ministry of Education of People's Republic of China last year.

(2) for the Chinese article you have published, what are the main differences between this paper and the Chinese one.

Answer: We checked the web site of the reviewer mentioned, the content is the abstract of a master thesis finished last year. Based on the pilot study of the thesis, two catchments' data were expanded to illustrate the different responses of streamflow and sediment load and the relationship to soil conservation measures and human activities exactly existing in the study area.

Specific comments:

1. The manuscript should be checked and edited by a native English speaker.

Answer: Thanks for the suggestion. The manuscript was checked and edited by a native English speaker. Besides revision following the suggestion of reviewers, other words were also revised in the manuscript.

2. The introduction section of this paper is not well written. I think the material is not well organized and not clearly presented.

Literature review: There has been significant work completed already in identifying change point of climatic and hydrological variables in China and abroad, and the authors have not been at all comprehensive in summarizing much of this work.

These publications should be acknowledged, besides authors should convince the readers the practical merit of their research.

Answer: Thanks for the suggestion. The research about the streamflow and sediment load on the Loss Plateau and in the Yellow River Basin was conducted very early in China. A great number of references talked about this topic in China and outside China. We organized and presented the "Introduction" of the paper as following:

"The Loess Plateau of 620 000 km^2 is located in the middle reaches of the Yellow River (750,000 km^2). It is characterized with heavily dissected landscape and severe soil loss resulted from wind-deposited loess soils, sparse vegetation, intense rainfall, and long agricultural history. To control the severe soil erosion, a number of soil conservation measures have been implemented on the Loess Plateau since the 1950s (Ye et al., 1994; Zhang et al., 1998; Ran et al., 2000), which mainly include afforestation, pasture reestablishment, terracing and sediment trapping dams. The measures resulted in great land use and land cover changes (LUCC) and dramatically altered hydrological regimes and significantly reduced sediment load in the Yellow River (Zhu, 1960; Liu and Zhong, 1978; Ran et al., 2000; Zhang et al., 2008; Rustomji et al., 2008). Apart from these, human activities in last five decades, such as population growth, increasing irrigation areas, reservoirs construction, industry development and coal mining, aggravated water resources crisis on the Loess Plateau (Liu and Zhang, 2004; Fu et al., 2004) and simultaneously affected sediment transport regime (Wang et al., 2007). The climate change has affected the Yellow River basin with the noted increase in minimum temperature and no appreciable change in precipitation in the last 50 years (Fu et al., 2004). Although the sensitivity of streamflow to precipitation, temperature or potential evaportranspiration was detected (Fu et al., 2007; Zheng et al., 2007), human activities were believed to be the primary driving force to the trends of streamflow and sediment load in the catchments and the main stream of Yellow River basin (Ran et al., 2000; Liu and Zhang, 2004; Fu et al., 2004 and 2007; Li et al., 2004; Wang et al., 2007; Zheng et al., 2007; Zhang et al., 2008; Runstomji et al., 2008; Gao et al., 2011)..

It is well known that afforestation and biophysical measures can alter catchment's water balance by increasing rainfall reception and evapotranspiration (Zhang et al., 2001; Brown et al., 2005). Soil erosion and sediment transport are therefore decreased through decreasing surface runoff and increasing water infiltration into soil (Colman, 1953; Morgan, 1986; Sahin and Hall, 1996; Castillo et al., 1997; Quinton et al., 1997). Huang and Zhang (2004), Mu et al. (2007), and Zhang et al. (2008) found that changes in streamflow tended to be relatively uniform across the flow spectrum with typical reductions of 30-60% in the catchments in the region due to soil conservation measures. From the 1980s, a great number of researches have been conducted and the results showed that sediment load in the catchments on the Loess Plateau tended to manifest a significantly negative trend and sediment retention benefit was estimated with soil and water conservation measures (Chen, 1988; Tang et al., 1993; Wang and Wu, 1993; Ye, 1994; Yu, 1997; Zhang et al., 1998; Ran et al., 2000; Wang and Fan, 2002; Yao et al., 2005 and 2010). Runoff-sediment behaviors are also believed to change because of the mechanisms of afforestation and check dams. As the change of sediment yield from a catchment probably resulted from one or both variables of suspended sediment concentration and discharge, how the sediment concentration change has been noted by the researchers. Xu (2002) and Liao et al. (2008) showed that the frequency of hyperconcentration flow, the main form of sediment transportation on the Loess Plateau, was decreased due to the implementation of soil conservation measures in the region. Rustomji et al. (2008) showed that mean annual sediment concentration in 7 of 11 catchments exhibited a statistically significant decreasing trend over time. A few researches focused on the relationship between streamflow and sediment load. However, the results were inconsistent and complex. Zheng and Cai (2007) concluded that increasing vegetation coverage didn't change the relationship between streamflow and sediment load in the paired catchments. However an opposite conclusion was drawn from Liu et al. (2010), who showed that the relationship between streamflow and sediment load changed obviously with land sue change in another paired catchments under heavy rainfall and high rainfall intensity. Rustomji et al. (2008) showed that although the results from the sediment rating curves based on the daily data support the conclusion of the variations of annual suspended sediment concentration, the soil conservation measures seemly did not significantly change the sediment rating curves in two years with the similar precipitation in two catchments on the Loess Plateau. Pan et al. (1999) indicated that the relationship between streamflow and sediment load in flood season did not change essentially in a region with area of 11×10^4 km^2 on the Loess Plateau.

Above researches indicate that LUCC resulted from soil conservation measures can affect hydrological regimes and in turn, sediment transport processes in a catchment. But it is not very clear how the soil conservation measures affect the relationships between streamflow and sediment load in a catchment. The inconsistent results are probably due to the data used, specific landform of the studied area, age and type of vegetation, soil characteristics, rainfall intensity, spatial scale focused on, and mixed nature of historic soil conservation measures. Obviously further researches are needed in this field. Furthermore, the "Grain for Green" project has been widely implemented from 1999. It is so important to fully understand the impacts of soil conservation measures and vegetation restoration on streamflow, sediment load, and runoff-sediment behaviors in the region to provide an integrated estimate for the effects of soil conservation measures on hydrology and sediment transportation and help ecological management in the catchments on the Loess Plateau. Therefore, the specific objectives of this study were to (1) examine the trends and change points of annual streamflow and annual sediment load over the last 50 yr in seven selected catchments on the Loess Plateau; (2) find the changes in the streamflow and sediment load represented by monthly flow/ sediment duration curves; and (3) investigate the changes in the dynamic relation of streamflow to sediment load in different periods in the catchments."

The following references were added in the paper:

Liu C.M. and Zhang X.C.: Causal analysis on actual water flow reduction in the mainstream of the Yellow River. Acta Geog. Sin., 59(3): 323-330, 2004 (In Chinese).

Fu, G.B., Chen,S.L., Liu,C.M., and Shepard D.: Hydro-climatic trends of the Yellow River Basin for the last 50 years, Climatic Change, 65:149-178,2004.

Fu, G.B., Charles, S.P., Viney, N.R., Chen, S.L., and Wu, J.Q. : Impacts of climate variability on stream-flow in the Yellow River, Hydrol. Processes, 21: 3431-3439, 2007.

Li, L.J., Zhang,L., Wang, H., Wang, J., Yang, J.W., Jiang, D.J., Li, J.Y., and Qin, D.Y.: Assessing the impact of climate variability and human activities on stremflow from the Wuding River Basin in China, Hydrol. Processes, 21(25): 3485-3491, 2004.

Gao, P., Mu, X.M., Wang,F. and Li, R.: Changes in streamflow and sediment discharge and the response to human activities in the middle reaches of the Yellow River, Hydrol. Earth Syst. Sci., 15: 1-10, 2011.

Wang, H.J., Yang, Z.S., Saitoc, Y., Liu, J. P., Sun, X.X., and Wang, Y.: Stepwise decreases of the Huanghe (Yellow River) sediment load (1950 – 2005): Impacts of climate change and human activities, Global Planet. Change, 57 (3-4): 331-354,2007.

Zheng, H.X., Zhang, L., Zhu, R.R., Liu,C.M., Sato, Y. and Fukushima, Y.: Responses of streamflow to climate and land surface change in the headwaters of the Yellow River Basin, Water Resour., Res., 45, W00A19, doi:10.1029/2007WR006665, 2009.

Tang,K.L. (Ed): The changes of erosion, runoff and sediment in the Yellow River, Science China Press, Beijing, China, 1993.

Liu, S.Y., Yu, X.X., Xin, Z.B., Li Q.Y., Li H.G. and Lei, F.Y.: Effects of land use change on runoff-sediment relationship at watershed in the loess hilly region, Prog. Geogr., 29(5): 565-571, 2010 (in Chinese).

3. I am not convinced that the method to determine change point in mean values and variance is the best way to identify points in the data record where changes have occurred. Many researches have identified change point of hydrological and climatic variables, at the very least, the authors need to convince the readers that the approach that they have selected possesses sufficient statistical power to warrant its selection in preference to one of the available alternative approaches. For example, please explain why you chose

Pettitt test to detect change point, but not other test such as Sequential Mann-Kendall test?

Answer: Thanks for reviewer's constructive comments.

Some critical references defined the change point (the abrupt climate change) and gave some detection methods by Fu and Wang (1992) from the institute of atmospheric physics, Chinese Academy of Sciences and Wei (1999) from the state laboratory of severe weather, Chinese Academy of Meteorological Sciences. In their suggestion, the methods commonly used include moving t –test technique, Cramer test, Yamamot test, Mann-Kendall test, Pettitt test and Lepage test. The former three methods focused on detecting the change in mean value and coefficient of variance, the latter three belong to non-parametric and rank-based tests.

From reference of Kundzewicz et al. (2004), the rank-based test is a kind of distribution-free method. They are recommended because they allow minimum assumptions to be made about the data and are therefore particularly suited to hydrological series, which are often neither normally distributed nor independent. Although they are usually less powerful than a parametric approach, rank-based test is considered to be robust to changes in distributional form and relatively powerful. Also they are usually simple to use.

We agree with the reviewer's recommendation that the results of change points detection should be validated each other. This point is also suggested by the references of Fu and Wang (1992) and Wei (1999).

We conducted the change point detection both using Pettitt test and Sequential Mann-Kendall test. The result of change points detected by pettitt test was generally highly consistent with that by Mann-Kendall test. The figures which show the test processes and the comparison with the original data series also attached as the supplementary file 1.

The change points detected using two methods are different in streamflow and sediment load in 2 catchments. Through comparing with the original data series, the change points by Pettitt test was considered to be rational, see the attached supplementary file 1.

In the manuscript, we used change points detected by Pettitt test, and the year 1999, when the "Grain for Green" project was implemented across the Loess Plateau, to divide three periods as P1, P2 and P3, respectively.

To make it clear, the words were written in the end of P5493 to explain the Pettitt test, see the attached supplementary file 2.

So, the corresponding change in word of Ln10 P5492 is following:
"3.2.1 Mann-Kendall test and Pettitt test".

And the orders of two equations are changed to (9) and (10) in P5494.

The words in Ln12-13 P5495 were rewritten as following:

"The change Points detected by Pettitt test and sequential Mann-Kendall test for annual streamflow in the five catchments were generally highly consistent and had a statistically significant level. To the difference of change point tested by two methods in Kuyehe River, the result detected by Pettitt test was considered to be rational as compared with the original data series (Figure 2 and Table 3)."

The words in Ln25-28 P5496 and Ln1-3 P5497 were rewritten as following:

"Change points of annual sediment load were detected by Pettitt test and sequential Mann-Kendall test and the results were generally consistent with each other except for Kuyehe River and Tuweihe River. As compared with the original data series of the catchments, change points detected by Pettitt test were considered to be rational, as shown in Table5. It is clear that change points of annual sediment load occurred also earlier in the three transition zone catchments, from 1977 to 1979, Whereas change points in the two rocky mountain catchments occurred later, both in 1982 (Table 5). Compared to Table 3, change points of annual sediment load in the five catchments were close to those of annual streamflow except Yunyan catchment, which implies that the effects of controlling soil erosion and sediment yield in these catchments have been achieved through the surface runoff reduction by soil conservation measures."

Following references are added in the references list of the manuscript.

Fu,C.B. and Wang Q.: The definition and detection of the abrupt climatic change, Secientia Atmospherica Sinica, 16(4):482- 493, 2004 (in Chinese).

Wei F.Y.(Ed): The modern climatological statistical diagnosis and forecasting methods, China Meteorological Press, Beijing, 62-76, 1999 (in Chinese).

Kundzewicz, Z. W., and Robson, A. J.: Change detection in hydrological records—A review of the methodology, Hydrol. Sci. J., 49: 7-17, 2004.

4. I agree with your conclusion of the effects of the LUCC on streamflow, sediment load, and their dynamic relations. However, I think the authors should add more discussion about their relation, and at least need to convince the readers understand the significance of your research.

Answer: Thanks for the constructive comments. We gave more discussion in some places.

The words in Ln3-6 P5498 were rewritten as following to argue why the poorer relationship between streamflow and sediment load was related to human activities. These two paragraphs were moved to place after ln21 5499:

"Compared to P1, the relationships between streamflow and sediment load generally became poor in the correlative coefficients from P2 to P3, especially in the transition zone catchments as well as Shiwang catchment, one of the rocky mountain catchments (Fig. 2b,c and g). On the Loess Plateau, human activities are recognized as the primary factor leading to the negative trends of streamflow and sediment load (Ran et al., 2000; Fu et al., 2004; Rustomji et al., 2008; Yao et al., 2010). But human activities are wide ranging and some of them can potentially increase soil loss in the catchments (Ran et al., 2000; Wang and Fan,2002).

The implementation of soil and water conservation was expected to control soil erosion and reduce sediment delivery to the Yellow River (Morgan 1986; Chen et al., 1988). The "Grain for Green" project implemented since 1999 resulted in a considerable improvement of vegetation coverage on the Loess Plateau. However, sediment trapping dams built up in the 1970s and 1980s were easily damaged by heavy rainstorm (Zhang, 1995). The ratio of silted storage to the total storage of reservoir was up to 40% in the seven catchments (Xiong and Ding, 1994). The variability of sediment concentration in the catchments in P2 was closely related to the ruined sediment trapping dams and the release regime of reservoirs (Zhang, 1995; Ran et al., 2000). Moreover, rapid urbanization and extensive infrastructure construction were simultaneously proceeding in the region (Liu and Han, 2007), which usually produced a huge amount of sediment deposition and dreg on the river bed and probably led to a high concentration flow, even in a medium event (Xu, 2002)."

The words in Ln4-6 P5499 were rewritten as following to explain why the absolute value of a constant was analyzed here:

"From "Preparation-transportation" process of soil erosion (Asselman 1999; Rovira and Batalla, 2006), the absolute value of a constant (with unit of $t.km^{-2}.mm^{-1}$) in the linear regression equation for each of the catchments implies a status of existing in-channel sediment storage in a given period to some extent, which can demonstrate the "sediment generation capacity" in another way."

The words in Ln2-6 P5500 were rewritten as following to argue why the characteristics of soil conservation measures may influence the dynamic relationships between streamflow and sediment load on the Loess Plateau:

"One was the total controlled area by soil conservation measures; and the other was the allocation of soil conservation measures. Xu and Sun (2006) showed that a threshold existed in the area of soil and water conservation measures in reducing sediment yield in Wudinghe River of the Loess Plateau. Yao et al. (2004) found that if the controlled area by dam-reservoir in a catchment was less than 10% of the total area, the trend of sediment load reduction would not be significant. But the differences in the mechanisms of evaportranspiration and hydrologic cycle regime with different landforms and vegetation coverage degrees probably determined the intrinsic differences in the trends and change degrees of streamflow and sediment load as well as their relationship between catchments. Although a number of studies supported the viewpoint from a single factor, further research is definitely needed to find an integrated estimate for more catchments."

The words following are added in the end of "SUMMARY":

"The results implies that future catchment management plans for the CSHC should acknowledge the effects on relationship between streamflow and sediment load by soil conservation measures and ecological restoration, and more sustainable measures should be considered to keep soil in site while not significantly affecting streamflow."

For the comments of anonymous Referee #3 in 22 June, 2012:

My overall comment is that this paper needs a substantial re-write to clarify the methods, the units of measure, and the interpretation of coefficients and changes in coefficients. Figure 2, which is critical to the analysis is virtually unreadable. The scales have no labels, the data are terribly crowded into a small part of each graph. Making them log-log plots and scaling them appropriately would go a long way towards making the paper more understandable. Also, the idea that these relationships (shown in figure 2) are actually changing, is the heart of the paper's hypothesis, and yet no statistical test was done to demonstrate that there really are differences among the three periods (analysis of covariance would provide such a test).

Answer: Thanks very much for the constructive comments. Based on the comments of referee 1, 2 and 3, we have improved the method description, the units of streamflow and sediment load and give more explanation of coefficients and changes in coefficients.

Figure 2 (Figure 3 after revision) was reworked using log-log plots to make the data more scattered following the suggestion.

Instead of "covariance" which is not very strong, "Chow test", a kind of F test, was used in the manuscript to demonstrate there really exists differences among the three periods within catchment. "Chow test" was invented by economist Gregory C. Chow (1960) and commonly used to test for the presence of a structural break in a time series analysis.

Page 5495, line 5-6, the units don't make sense. They have dimensions of L3*L-2*L-1*T-1 The net result of this is dimensions of T-1. I think the mm-1 is extraneous.

Answer: To make the change of streamflow and sediment load comparable in catchments, the volume of streamflow (m^3) and the amount of sediment load (t) were standardized with controlling area (km^2) and precipitation (mm). So the units of standardized streamflow and sediment load were "$m^3.km^{-2}.mm^{-1}$", "$t.km^{-2}.mm^{-1}$", respectively. For streamflow, in fact it is dimensionless and signifies the runoff availability (m^3) per km^2 area and per mm precipitation.

Words in ln5-8, P5492 read now:

"So a unit for streamflow is "$m^3.km^{-2}.mm^{-1}$", which is dimensionless, the value is 1000 times the runoff coefficient and means the runoff availability (m^3) per km2 area per mm precipitation in a catchment in a given period. And a unit for sediment load, "$t.km^{-2}.mm^{-1}$", actually signifies sediment availability (t) per km^2 area per mm precipitation in each catchment in a given period."

Due to the standardization of data, the words in Ln5-6 P5495 read now:

"Average change rate of annual streamflow was -3.39 per year in the three transition zone catchments, but only -0.67 per year in the two rocky mountain catchments."

Page 5495 and Table 3. The streamflow records are evaluated for monotonic trends (Mann-Kendall) and change point (Pettitt), but the authors don't seem to suggest which one of these is a better characterization of the changes. Presentation of time series graphs for these data sets would be very helpful and the authors need to suggest their preferred interpretation. The methods section explains the Mann-Kendall test but not the Pettitt test and yet both are used in table 3. The authors need to explain their methods.

Answer: In this study, nonparametric Mann-Kendall method was used to test trends in streamflow and sediment load in catchments. If a significant trend was tested, nonparametric Pettitt method was applied to test if change point existed in the data series. At the same time, sequential Mann-Kendall method was also used to validate these change points.

A new figure (Figure 2) was presented to illustrate the data series of standardized streamflow in seven catchments and the change point years detected using Pettitt test in five catchments and given in another two catchments.

Thanks very much for your reminding. The missing words in the method section were appended in P5493 to describe the method of

Pettitt test.

Page 5514. Figure 2. These plots are very hard to read. They would be much improved streamflow and load were both plotted on a log scale. Even better than that, if the y-axis would show flow-weighted mean concentration (that is, monthly load/monthly flow). Most of the variation in load is due to flow itself, so the plots make it very difficult to discern the differences between the three periods. It is not clear why the x-axis always ends at 1400. In several of the graphs the data are all bunched up at the left edge of the graph, making it very difficult to see the spread. As they are, the plots really do not convey the information that the authors want to convey. Conversion to a log-log scale is crucial to making them useful.

Answer: Following the suggestion, Figure 2 (after revision, it is Figure 3) was reworked using log scale both in X and Y axis. It is better to see the spread of the data now. The variation in load resulting from the flow was discussed in P5499 of the revised manuscript, the relationship between streamflow and sediment load was weakened from the analysis and also discussed from the nature of human activities on the Loess Plateau in section 4.3. There were no specific reason for x-axis ending at 1400. The purpose was to compare the differences in behavior of streamflow and sediment load in catchments under one same scale. After log-log transition in X and Y axis, the scope was found to be in (2000,1000).

The units on the x and y axes of these graphs needs to be shown either on the graphs or in the caption. The equations shown on the figures are all linear, and yet the graphs show curves. I suspect that this is because the equations were fit on logarithms (but I'm not sure).

Answer: Units of streamflow and sediment load were shown both in each graph and caption. From the graphs, some catchments has high correlation coefficients in linear regression, that means the relationship between streamflow and sediment load can be represented well using linear equation for monthly data in the study.

Other functional relationships were fitted to the data, for example power and logarithms, results were not satisfied at all.

Where are x and y defined? The authors seem to want to show that these relationships are different for different periods. The standard way of doing that is to use analysis of covariance. I see no indication that there was any effort to demonstrate in a statistical sense that the periods are different.

Answer: For now, x and y in Figure 2 (after revision, it is Figure 3), are defined in Ln1-2 P5498 as following:

"Streamflow and sediment load were showed as X and Y axis variables in Figure 3, respectively."

The relationships between streamflow and sediment load among three periods in catchments were tested using "Chow test", which is commonly used to test if there was a structural break in a time series analysis. The words talking about the test as following in 2nd paragraph of P5498:

"Before analysis of the trend and change of the coefficient of equation, the structure of linear regression between streamflow and sediment load was tested using Chow test to see if there was statistical difference in their relationship among three periods in each catchment. Chow (1960) constructed F test to detect the presence of a structural break and commonly used in time series analysis. The results showed that there was statistically significant difference with $p < 0.05$ in relationship between streamflow and sediment load among periods in six catchments except for Yunyan, one of rocky mountain catchments. The result was basically consistent with the annual trend test in Table 3 and 5, but the disagreement between annual trend and monthly relationship in Qingjian, Yanhe and Yunyan catchments was probably due to the hydrological regime in monthly scale, which greatly affected the relationship. "

Following reference are added in the list of references of the manuscript.

Gregory C. Chow (1960). "Tests of Equality Between Sets of Coefficients in Two Linear Regressions". Econometrica, 28 (3): 591–605. DOI:10.2307/1910133.

Page 5497, lines 21-22. The statement about the changes being larger for sediment load as compared to flow need to be put in context. Because load is generally a nonlinear function of flow we would expect that load trends would be larger than flow trends (expressed in percentage terms). The key question is, are the load trends simply a reflection of the flow trends or is the relationship between flow and load changing?

Answer: Thanks for the comments. It is key question in this study even in the research field. From the whole study, five of seven catchments have significant negative trend in both of annual streamflow and sediment load. At the meantime, the relationship between monthly streamflow and sediment load also changed with siginificant level in six of seven catchments. In general, the conclusion could be drawn that the change of sediment load was the result both of the change of discharge and their relationship.

This conclusion was strengthened in abstract, summary and section 4.3, respectively.

Page 5498, line 3, use the words "correlation" not "correlative".

Answer: Thanks for reminding. The word has been changed in the revised manuscript.

Page 5498, lines 4 and 5. The logic is not explained. Why does poor correlation between load and flow indicate that the "periods were largely influenced by human activities." This seems to be a very important conclusion, but no logic is presented to justify it.

Answer: Thanks for reminding. The relevant words were added to discuss the point of view as following in P5499:

"Compared to P1, the relationship between streamflow and sediment load generally became poor in the correlation coefficients from P2 to P3, especially in the transition zone catchments as well as Shiwang catchment, one of the rocky mountain catchments (Fig. 2a, b, c and g). On the Loess Plateau, human activities are recognized as the primary factor leading to the negative trends of streamflow and sediment load (Ran et al., 2000; Fu et al., 2004; Zhang et al., 2008; Rustomji et al., 2008; Yao et al., 2010). But human activities are wide ranging and some of them can potentially increase soil loss in the catchments (Ran et al., 2000; Wang and Fan, 2002).

The implementation of soil and water conservation was expected to control soil erosion and reduce sediment delivery to the Yellow River (Morgan 1986;

Chen et al., 1988). The "Grain for Green" project implemented since 1999 resulted in a considerable improvement of vegetation coverage on the Loess Plateau. However, sediment trapping dams built up in the 1970s and 1980s were easily damaged by heavy rainstorm (Zhang, 1995). The ratio of silted storage to the total storage of reservoir was up to 40% in the seven catchments (Xiong and Ding, 1994). The variability of sediment concentration in the catchments in P2 was closely related to the ruined sediment trapping dams and the release regime of reservoirs (Zhang, 1995; Ran et al., 2000). Moreover, rapid urbanization and extensive infrastructure construction were simultaneously proceeding in the region (Liu and Han, 2007), which usually produced a huge amount of sediment deposition and dreg on the river bed and probably led to a high concentration flow, even in a medium rain event (Xu, 2002)."

Page 5498, lines 7-11, I really don't understand this paragraph at all. What are the numbers (1400, 1000) intended to represent? What units do they have? Is this difference just a reflection of basin size or climate? What is the importance of this observation?

Answer: For both X and Y axis were represented as log scale, the data distribution from the scope of 1400 in x-axis and 1000 in y-axis was changed to the scope of 2000 in x-axis and 1000 in y –axis. The differences between catchments is a reflection of other factors such as hydrology geology, soil and climate as well as. To describe their distributing scope is to illustrate the difference from different aspects. The words Ln7-11 P5498 read now:

"The range of the scattered distributions of monthly sediment load against monthly streamflow in the three transition zone catchments is up to {2000,1000}, whereas in the two rocky mountain catchments, only {500,100}. Apparently, the former is much wider than the latter. The range of the scattered distribution in the two loess hilly-gully catchments lies in the middle. The factors, such as frequency of rainstorm, vegetation coverage, soil and hydrological geology were supposed to determine the distribution scope of streamflow and sediment load in catchments (Ran et al., 2000)."

Page 5498, lines 12-23, there is a set of interpretations made here about the regression coefficients. What are the units of these coefficients? What do the represent (stated in words)? Without this background it is impossible for the reader to understand the interpretation made.

Answer: The linear relationship was obtained from two variables of streamflow and sediment load. So the unit of regression coefficients here is $t.m^{-3}$, which means sediment availability (t) per unit streamflow (m^3) in a mean annual status in a given period in a catchment. In general the regression coefficient represents the sediment generation capability in a given period in a catchment. The unit was given and the words was rewritten in ln12-23 P5498.

"The regression coefficients (with unit of $t.m^{-3}$) can be considered as "sediment generation coefficients" because they may indicate the sediment generation capacity in the catchments. Figure 3 shows that the linear regression coefficients, in general, are much higher in the transition zone catchments and the loess hilly-gully catchments than those in the rocky mountain catchments. The average coefficients in P1, P2 and P3 are 0.4723, 0.3164 and 0.0891 in the three transition zone catchments and 0.5519, 0.4728 and 0.5093 in the two loess hilly-gully catchments, while they are only 0.1513, 0.1336 and 0.0932 in the two rocky mountain catchments. This indicates that as for per unit of streamflow, the catchments located in the transition zone and loess hilly-gully area had a stronger capacity to generate and transport sediment than the catchments in the rocky mountain area. The reason is apprently related to the high vegetation coverage in the rocky mountain area catchments, as shown in Table 1."

Page 5499, lines 4-14, What is the basis for the interpretation of the meaning of the intercept? What are the units?

Answer: To some extent the constant in the linear regression implies the existing in-channel sediment storage in a given period when the streamflow equal zero. The possitive value means the silted status in river bed and negative value means the scoured status in river bed. The unit of a constant is "$t.km^{-2}.mm^{-1}$". The unit was given and words were rewritten as following in ln12-13 P5499.

"From "Preparation-Transportation" process of soil erosion (Asselman 1999; Rovira and Batalla, 2006), the absolute value of a constant (with unit of $t.km^{-2}.mm^{-1}$) in the linear regression equation for each of the catchments implies a status of existing in-channel sediment storage in a given period to some extent, which can demonstrate the "sediment generation capacity" in another way."