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Hydrology and Earth System Sciences Discussions

Interactive comment on "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* Z. L. Gao et al.

X. Zhang

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Thanks very much for the constructive comments of 23 May 2012 regarding the above manuscript. I have answered the comments one by one and therefore revised the manuscript accordantly. Also a detailed list of relevant changes made in the manuscript was presented in the file.

As attached file, the complete manuscript was also uploaded to show how and where the words or sentences were revised and the paragraphs were adjusted. In which the parts marked yellow color are those revised in the manuscript and blue words are revised following the reviewer's comments and red words are revised through proof-reading by English native speaker.

I hope you will agree with that.

For the comments of anonymous Referee #2:

(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 work of the master thesis hasn't been published yet till now.

The master is as 2nd author in the coauthors of this paper.

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. No any paper has been published from the thesis till now. 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. All the places we changed word or rewritten sentences were listed as 5th part in this list.

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 or outside China. We organized and presented the "Introduction" of the paper as following:

"The Loess Plateau of 620 000 km2 is located in the middle reaches of the Yellow River (750,000 km2). 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 trend 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 transportation 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 1980s, a great number of researches have been conducted and the results showed that streamflow and 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; 2010). Runoff-sediment behaviors are also believed to change because of the mechanisms of afforestation and check dams from the researches. 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 of streamflow and sediment load. However the results were complex and inconsistent. Zheng and Cai (2007) concluded that increasing vegetation coverage didn't change the relationship of streamflow and sediment load in the paired catchments. But a different conclusion was drawn from Liu et al. (2010), who showed that the relationship of streamflow and sediment load changed obviously with land use 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 ïĆť 104 km2 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 the 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.

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).

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.

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

We agreed 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 Mann-Kendall test. The result of change points detected by pettitt test was generally high consistent with that by Mann-Kendall test as following tables. The figures which show the test processes and the comparison with the trend of original data series also attached in this file.

The change point detected using two methods is different in streamflow in Kuyehe River, one is 1981 by Pettitt test, and one is 1992 by Mann-Kendall, see Table 1. Through comparing with the original data series, the change point in 1981 by Pettitt test was considered to be rational, see the attached Figures.

The change point detected using two methods is different in sediment load in Kuyehe River and Tuweihe River, see Table 2. But from comparison with the original data series (attached file 5), the change points tested by Pettitt method were considered to be rational.

Attached file1 here.

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From Table 1, non 2nd change point was detected in streamflow with both tests and the 2nd change point was tested in sediment load only in 3 of 7 catchments. So in the paper, we used change points detected by Pettitt test with most statistical significant level, i.e. 1st change points, 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 clearer, we add the words in the end of P5493 as attached file 1.

The following reference is therefore added in the paper.

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

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 with 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 (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 cathcments, 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

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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."

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: Agree with reviewer's comments. The arbitrary conclusion about the change of relationship between streamflow and sediment load needs more explanation. 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. And also these two paragraphs were moved to the end of this section as paragraphs7 and 8:

"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 im-

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provement 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:

"In this study, the absolute value of a constant in the linear regression equation for each of the catchments implies 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 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 as following are added in the end of "SUMMARY":

"The results imply that future catchment management plans for the CSHC should acknowledge the different effects on streamflow and sediment load, and their relations in catchments by human activities, and develop more sustainable measures to keep soil in site while not significantly affecting streamflow."

5. The places we changed word or rewritten sentences:

1). The title of the paper was changed to "Trends of streamflow, sediment load and their dynamic relation for the catchments in the middle reaches of the Yellow River over the past five decades "

2). P5488:

Ln3, "been adopted" was changed to "been implemented";

Ln9, "with precipitation" was changed to "with the precipitation";

Ln13, "to express their dynamic relation" to "to express their relationship";

Ln16-17, "the change extents in" to "the change degrees of", Ln16-17, "their dynamic relation between catchments" to "their relation for the catchments";

Ln20, "their dynamic relation" to "their relationships";

Ln22, "the change extents" to "the change degrees";

Ln24-25, "the dynamic relation between the periods" to "the dynamic relations period by period".

3). P5490

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Ln22, “The 1.13 ïĆť 105 km2 coarse sand hilly catchments (CSHC) on the Loess Plateau is. . . . . .” changed to “The coarse sand hilly catchments (CSHC) with a total area of 1.13 ïĆť 105 km2, on the Loess Plateau, are. . .. . ..”.

4). P5491

Ln3, “with a thickness of 50-200m” changed to “with thickness of 50-200m”;

Ln5-6, “for the purpose of the study, details of which are given in Table 1” changed to “for the purpose of study, and details of which are given in Table 1”;

Ln14, “which are collected through census” changed to “which were obtained through cencus”

Ln16, “The rates of increase were greatest during 1970s and 1980s.” changed to “The increased rates were the greatest in the 1970s and 1980s”

Ln16-19, “The vegetation cover,. . .. . . .” changed to “The vegetation coverage, . . .”; “in last 20 yr” changed to “in the last 20 yr”.

Ln26, “An area-weighted method” changed to “Area-weighted method”.

5). P5493

Ln18, “ïĄć is median of all possible combinations of. . ..” changed to “ïĄć is the median of all possible combinations of. . .. ”

6). P5494

Ln2,“on the Mann-Kendall test” changed to “on Mann-Kendall test”;

Ln5, “before applying the Mann-Kendall test” changed to “before applying Mann-Kendall test ”;

Ln6, “to detect the autocorrelation of the data” changed to “to detect the autocorrelation of the data used in the study”;

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Ln15, “The critical values of r1„ . . .. . .” changed to “The critical values of the calculated lag-1 serial correlation coefficient,r1,. . ...”;

Ln16-17, “If the calculated lag-1 serial correlation coefficient,r1,is not significant at the 5% level,. . .” changed to “ If r1 is not significant at the 5% level,. . .”.

7). P5495

Ln2, “4.1 Trends, change points and changes in hydrological regimes for streamflow” changed to “ 4.1 Trends, change points and changes for annual streamflow”;

Ln7-8, “The average change rate for the former was about 5 times that for the latter.” changed to “Average change rate for the former was about 5 times that for the latter.”;

Ln9-11, “The change rate in Qinjian catchment presented a slightly increasing trend, but in Yanhe catchment, a slightly decreasing trend, both of which were statistically insignificant (Table 3)” changed to “Change rate of the annual streamflow in Qinjian catchment manifested a slightly increasing trend, but in Yanhe catchment, a slightly decreasing trend, both of which were statistically insignificant (Table 3)”

Ln16-18, “The reason for such an occurrence is probably related to the time when the cumulative area of soil conservation measures in the catchments reached about 15%.” Changed to “The reason for the different change point is probably related to the time when the cumulative area for soil conservation measures in the catchments reached about 15%.”;

8). P5496

Ln18, rewritten to “4.2 Trends, change points and relative changes for annual sediment load”;

Ln19-24, rewritten to “Like annual streamflow, annual sediment load in the five catchments except the two loess hilly-gully catchments showed statistically significant decreasing trends and change points (Table 5). Average change rate of annual sedi-

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ment load in the three transition zone catchments was -0.5547 t.km-2.mm-1.a-1, and in the two rocky mountain catchments, only -0.0540 t.km-2.mm-1.a-1. Clearly, average change rate for the former was nearly 10 times that for the latter."

9) P5497.

Ln6-10, rewritten to "Table 6 shows that compared to P1, relative changes of sediment load in all the seven catchments were negative at the high(5%), median(50%), and low(95%) percentiles of sediment transport regime in the two latter periods. Days of zero sediment load increased in all the catchments, including the two loess hilly-gully catchments."

Ln11-22, rewritten to

"For the three transition zone catchments, average relative changes at the high (5%), median (50%) and low (95%) percentile sediment load in P2 were 56.0%, 60.2%, and 33.5% and in P3, 93.7%, 88.6%, and 71.8%, respectively. There were considerable differences in the relative change between the two periods. For the two rocky mountain catchments, average relative change at high sediment load was 58.9% in P2 and 78.4% in P3. The result indicates significant effects of soil conservation measures and the "Grain for Green" project on sediment transportation in the study area. However, the effect of "Grain for Green" project implementation is much greater than that of soil conservation measures due to the continuity in the implementation process. Change degrees of annual sediment load were much greater than those of annual streamflow."

10). P5497,

Ln23, rewritten to "4.3 Dynamic relation of streamflow to sediment load in the catchments"

11). P5498,

Ln12-23, rewritten to

"The regression coefficients can be considered as "sediment generation coefficients" because they may indicate the sediment generation capacity in the catchments. Figure 2 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."

Ln27-29 P5498 and Ln1-3 P5499:

"Compared to P1, the average reduction rate of linear regression coefficients in P2 was 31.2% in the transition zone catchments and only 18.0% in the rocky mountain catchments, but in P3, it was up to 83.2% and 60.8%, correspondingly. However, the negative trend was not evident in the loess hilly-gully catchments. Average reduction in P2 in all the seven catchments was 22.5% and in P3, 55.4% (Table 7).

12) P5499

Ln5-14, rewritten to:

"In P1, much more sediment was stored in the three transition zone catchments than in the two loess hilly-gully catchments and the two rocky mountain catchments (Fig.2). Correspondingly, average sediment storages were 68.6, 23.3 and 6.3, respectively. Generally sediment storage in the catchments showed a decreasing trend period by period except Qingjian catchment in the loess hilly-gully region. Compared to P1, soil conservation measures adopted in the 1970s and 1980s reduced sediment storage by 56.9% in the transition zone catchments and the "Grain for Green" project implemen-

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tation further reduced it by 95.7%."

Ln16-21, rewritten to:

"The standardized streamflow volume at which the balance is needed for a catchment showed a decreasing trend with the shifted period in most of the catchments (Table 8). Especially in the three transition zone catchments, average reduction of the streamflow volume for the balance reached 38.0% in P2 and up to 80.6% in P3."

Ln22-27, rewritten to following words and moved to the end of this section:

"In a word, the trends of three indices, i.e., regression equation coefficient, regression equation constant and the streamflow volume at which a scour and silting balance reached, are found to be increasingly negative in most of the catchments. The decreased trends indicate that soil conservation measures and the "Garain for Green" project considerably weakened the sediment yield capacity and the dynamic relation of sediment load to streamflow in the study catchments".

Ln28-29, rewritten to:

"In consideration of the standardization of the data by precipitation and catchment area, the decreasing/weakening trends of streamflow, sediment load, and their dynamic relations in the catchments were probably related to the characteristics of soil conservation measures adopted after the 1950s."

13). P5500,

Ln8-10, rewritten to:

"The result agrees with those from Dai and Yan (2002), Zhang et al. (2008), probably due to other kinds of human activities which aggravate soil erosion and increase sediment transportation in the catchment."

Ln15-27, P5500 and L1 P5501, rewritten to:

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“The responses showed a great variety, but generally three types could be identified based on the spatial distribution of the catchments. Both annual streamflow and annual sediment load presented significant negative trends and change points in the three transition zone catchments and two rocky mountain catchments. In most of the cases, the decreasing change degrees of streamflow and sediment load in the three sandy transition zone catchments were greater than those in the two rocky mountain catchments. Change points detected in the sandy transition zone catchments were earlier than those in the rocky mountain catchments. Change degrees with the shifted periods in sediment load were much greater than those in streamflow, especially in the three sandy transition zone catchments. The non-linearity of runoff-sediment production processes resulted in a statistically significant weakening trend in their relationship in the catchments. The implementation of soil conservation measures from the 1970s to 1980s reduced the sediment generation capability in the catchments by 22.5% and the subsequent “Grain for Green” project since 1999 further reduced it by 55.4%.”

14). P5503-5504,

In the reference list, The reference of Xu and Su (2006) was published on “Advances in Water Science” of Chinese journal. Not sure what ‘s the brief journal title for it. The reference of Zhang (1995) was published on “Yellow River” of Chinese journal. Not sure what ‘s the brief journal title for it.

15).P5506,

For table 2, the values for Tuwei catchment were changed as attached file 2.

16) P5507,

For table 3, the title was changed to “Trends of the annual streamflow and change points by Mann-Kendall and Pettitt test”. And note “b” was added to the column “Slope(β)” to explain the unit of “Slope(β)” is essentially dimensionless and the value in the column means the change rate of the runoff coefficient in catchment like attached

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file 4.

17) P5509

For table 5, the title was changed to “ Table 5 Trends of the annual sediment load and change points by Mann-Kendall and Pettitt test”.

18) P5511

For Table 7, “(%)” was appended to the title;

The two number in the “average” row changed to “-22.5” and “-55.4”, respectively.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/9/C2245/2012/hessd-9-C2245-2012-supplement.zip

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 5487, 2012.