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Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Variations in the characteristics of Changjiang sediment discharging into the sea due to human activities" *by* J. H. Gao et al.

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Dear referee who gave the comments, My co-authors and I wish to thank the reviewers and editor for the comments and suggestions which we found very useful and relevant for improving the manuscript. In addition, the revised manuscript is also uploaded as a supplementary.

1. Source and reliability of the data (Section 3.1). While I have no issues per se with the data and its sources used here, the data does not appear to have been used in any previous work. There appears to be no references which is strange for a data set that

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covers a 55 year period. Is this the case? Further, given that the data does not appear to have been used, a much better description is needed. Information such as how the data was collected and how often, sample analysis methods and quality control, how missing data was managed together with methodological consistency described. Without this information the reader does not have confidence in the data.

Response: All data concerning with water and sediment discharge in this is is published by authorities of Chinese government. We supplement the source and reliability of the data in the revised manuscript (Section 3.1.1): The long-term discharge and sediment monitoring program over the entire catchment has been conducted since the 1950s, by the Changjiang Water Resource Commission (CWRC) under the supervision of Ministry of Water Resources, China (MWRC). These monitoring data include field survey and measurement of discharge, suspended sediment concentration, suspended sediment load, and suspended sediment grain size, in accordance with Chinese national data standards (Ministry of Water Conservancy and Electric Power, 1962, 1975): 10-30 vertical profiles within the water column were selected for the measurements of each river cross-section, the number of profiles varying with the width of the river; For each profile, the water flow velocity (using a direct reading current meter) were measured at different depths (normally at surface, 0.2H, 0.6H, 0.8H and the bottom, where H is the height of the water column); Meanwhile, the water mass of the same depth were also sampled for measuring the suspended sediment concentration and grain size; the sediment grain size is measured using the settling of suspensions method. All above measurements are repeated daily at each station. The homogeneity and reliability of the hydrological data, with an estimated daily error of 16% (Wang et al., 2007), has been checked and firmly controlled by CWRC before its release. The data during the period of 1956-2001 was either published in the Yangtze River Hydrological Annals or provided directly by CWRC. After 2002, these hydrological data were posted in the Bulletin of China River Sediment published by the Ministry of Water Resources, China (BCRS, 2002-2010; available at: http://www.mwr.gov.cn/zwzc/hygb/zghlnsgb/).

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2. The paper is examining the role dam emplacement has had in altering suspended sediment flux. However, the site map (Figure 1) is near impossible to read given its size and complexity. The reader needs to be able to easily follow the flux downstream. Further, there are no dates in the text (that I could find) when individual dams were completed again so that fluxes could be followed. Maybe a flow diagram would help with this. It is really important to be able to understand the connections and lags in the system.

Response: Revised. The figure 1 was re-drawn. In the revised Fig. 1, some important reservoir sites (Fig. 1a), and all the reservoirs (Fig. 1b) we counted are shown. In addition, in the revised Fig.2 and Fig.3, when and how individual dams exerted impact on the sediment load, as well as their relationship is expressed.

3. The statistical treatment throughout the paper is very confusing. There is no problem with the description of the Analytical Methods (Section 3.2) but how and where this applied to the data throughout the text is not clear. This is compounded by the straight lines included in the individual plots in Figure 2 which suggest that they are part of the autocorrelation assessment or some other statistical treatment. Later on in Section 4 and 5 differences in sediment output are described and there is the suggestion that these are presented because of statistical similarity or difference but it is never made clear. Also, could any correlations be influenced by poor quality data or data that is poorly temporally consistent (see Comment 1)? This really lets the paper down.

Response: Revised. The Section 4 and 5 were rewritten. In the revised manuscript: firstly, according to the M-K trends of sediment load, the time nodes, i.e. the beginning time of sediment load decreasing, and the statistical sediment load decreasing trends occurring qualitative change, are confirmed; subsequently, the variations of the sediment load entering the sea of the Changjiang could be divided into four stepwise reduction stages namely, 1956-1969, 1970-1985, 1986-2002, and 2003-2010; thirdly, variations in quantity, composition and grain size of Changjiang sediment discharging into the sea during these four period in response to human activities are discussed. In

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addition, the source and reliability of the data is supplemented (see response 1 or the Section 3.1.1 of the supplementary).

4. Results. I realize that there are a large number of sites and data which are examined in this paper. However, the way the data is presented in the text is near impossible to follow. There are too many sites, numbers and dates for any real understanding to be made by anyone not intimately familiar with the sites and data. The Results need a thorough reworking with (1) a minimum amount of numbers in the text with (2) the data places and summarised in a table or by some other means. Also, examining Figure 2, can something be said about the large variation in output? The variability of sediment transport is worthy of some comment in its own right.

Response: Revised. The section of result and discussions was thoroughly re-organized and re-written, according to reviewer's suggestion. The following revision has been made in section of results: firstly, we compare the changes of the total RSCI with that of the sediment load of tributaries and the whole Changjiang catchment, the results indicate that the stepwise decrease of sediment load is highly related to the significant increase of the total RSCI, reflecting the impact dams have on sediment load; secondly, derived on the basis of the M-K method, of sediment load of the seven tributaries, the spatial-temporal sediment load variations within the catchment are acquired; thirdly, based on the M-K trends of sediment load variation at Datong station, four stepwise reduction stage periods of the sediment load discharging into the sea of the Changjiang were divided, and the factors leading to the sediment load into the sea between adjacent time periods gradually decreased were also analyzed; lastly, the variations in the grain size of the sediment entering the sea during different periods were explored. In addition, the Fig.2 was redrawn and a new Fig.3 was supplemented in the revised manuscript. These two figures indicated, the changes of the total RSCI and sediment load of tributaries and the whole Changjiang catchment indicate that the stepwise decrease of sediment load is highly related to the significant increase of the total RSCI. In addition, over the last few decades, the cumulative water and sediment

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discharge relation of each tributary continuously changed, with the slop of curve decreasing, and every turning point of the curve was closely related to dam construction (Fig. 3). The above two relationships reflected the impact dams have on sediment load.

5. Other comments. (a) Given the scale and pace of development in the region, what role have changes in hillslope management had in sediment transport? Could changes in vegetation type and cover influenced your finding? Were there hillslope/subcatchment practices that could have influenced sediment transport?

Response: Supplemented. Due to intensified human activities, the catchment forest vegetation was continuously destroyed, and the forest coverage rate of Changjiang River Catchment greatly reduced (Xu, 2000), thereby leading to the ecological environment seriously deteriorated (Lu and Higgitt, 2000). Starting from late of 1980, a large-scale soil conservation campaign was implemented in high sediment yielding regions of the upper Changjiang catchment. However, due to the natural conditions difference of the upstream Changjiang River Catchment, the effect of soil conservation campaign starting from 1989 was discrepant in every upstream tributary. For example, the most of Jialing River watershed is hills areas, and mainly suffered from slope erosion (Zhang and Wen, 2004). In addition, its vegetation restoration rate is quite high due to the humid climate, and then the effect of vegetation recovery on reducing slope erosion is very prominent (Lei et al., 2006). Therefore, the sediment yield of Jialing River watershed rapidly decreased since the soil conservation campaign carried out in 1980s (BSWCïijŇ2011), and the land cover variation exerted more important impact on the sediment load reduction. The downstream Jinsha River with 782 km in length is the main sediment yield area; although its area only account for 7.8% of upstream Changjiang River, the average annual sediment load reach 35.50% of that of the Yichang station (Zhang and Wen, 2004). This reach with developed landslide and debris flow, is characterized by high and steep mountains, and deep valleys, which is not beneficial to vegetation restoration (Lei and Huang, 1991ïijŻYang, 2004). There-

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fore, the water and soil erosion governing effect in Jinsha River Watershed was not as obvious as that in Jialing River watershed (BSWC, 2011), reservoir interception is still the dominating factor leading to the sediment load reduction. Jinsha River supplies most of the sediment to the upstream Changjiang. In addition, after 1989, the total reservoir storage capacity also greatly increased in the upstream of Changjiang. Thus, the soil conservation campaign accelerated the decreasing trend of the sediment grain size of Yichang station; but it is very difficult to quantitively evaluate the contribution of dam construction and land cover change.

(b) Page 9122, Section 4.2, line 11. How did you calculate the load of 503Mt/yr? This does not seem to connect with any other data. Line 26. Do you mean statistically significant?

Response: 503 Mt/yr is arithmetic mean value of sediment load of Datong station during 1956-1969. The annual sediment load of Datong staiton during 1956-2010 is shown in Fig.2. In Fig. 4 of the revised manuscript, during the period of 1956-2010, the sediment load of Wu River, Jialing River, Min River and Jinsha River began to decrease in 1984, 1985, 1994 and 2001, respectively, suggesting that the downstream sediment load began to decrease earlier than the upstream sediment load in the upstream of Changjiang catchment.

(c) Section 4.3, first para. Do you mean statistically significant? Also, the following work, is it yours or that of Xu (2005). This is unclear.

Response: The study of Xu (2005) demonstrated that, in the past 40 years, grain size of suspended sediment load of major tributaries of the upper Changjiang River has a decreasing trend; and this decreasing trend can be explained by the effect of reservoir construction and implementation of soil-water conservation measures. Our work is very different from his. We not only analyzed the variation trends in grain size of upstream sediment, but also the Changjiang sediment into the sea. But even more important, we pay more attention to the variation of sediment fraction of Changjiang entering the sea,

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for example, although the average value of the grain size of the sediment entering the sea during the different periods exhibited no clear variations, the inter-annual variation range and sediment components and origin changed considerably.

(d) Section 5.1, page 9125, para starting line 17. This paragraph is impossible to follow. The issues surrounding data description as well over confusing data origins make this section difficult to rationalise. Similar comment can be made for Section 5.2

Response: In the revised section of discussions, the content irrelevant to the sediment load, composition and grain size were deleted. We mainly systematically discussed the variations in sediment load and different sediment fraction originating from tributaries within the Changjiang catchment during different historical periods.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/11/C4055/2014/hessd-11-C4055-2014-supplement.zip

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