We would like to thank the referee for the valuable comments and suggestions, which all have been considered in the final version of the manuscript. Then, we re-define the hydrological connectivity index model, and strengthen the methodology explanation. We would submit one manuscript “Spatial Analysis of Damaged Vegetation in the Mianyuan River Basin after the Wenchuan Earthquake”, and this manuscript is focused the slope material stability model.

In addition, we would use a professional English editing service or have the revised manuscript checked by a native English speaking colleague.

The mainly revised parts of the manuscript as the following show;

1 Hydrological connectivity index model

Mass wasting processes in mountainous terrain are not only dependent on the overall terrain, but also on the spatial organization and the internal connectivity of various topographic units (Bracken et al., 2014;Borselli et al., 2008;Blahut et al., 2010;Croke et al., 2005;Rogelis and Werner, 2014). Bracken et al (2014) proposed that the sediment connectivity can be used to explain the continuity of sediment transfer from a source to a sink in a catchment, and movement of sediment between different zones within a catchment: over hillslopes, between hillslopes and channels, and within channels(Bracken et al., 2014). Borselli et al (2008) defined one connectivity index (*IC*) to evaluate the potential connection between hillslopes and sinks. Based on the existing models, this paper presents one definition of hydrological connectivity index (*HCI*). The definition is based on the fact that mass wasting processes depend on its size of upslope source zone and position in the mountainous catchment (Fig.5), which consists of two components: the upslope component F_u and downslope component F_d. And, the definition model can be expressed as:

$$HCI = \ln(\frac{F_u}{F_d}) . \qquad (2)$$

This defined model is presented linking hydrological connectivity with the ecological processes in the Wenchuan Earthquake-hit region, for it assesses the weight factor of slope materials through monitoring the vegetation changes before and after the earthquake.

1.1 The upslope component F_u

The upslope component F_u depends on the conditions of the upslope contributing area, such as topographic environments, and vegetative conditions. It is aimed at estimating the sediment production and the flow accumulation of the upslope contributing area. And, F_u depends on the topographic conditions (e.g. size, relative relief, and slope gradient) and surface materials of the upslope contributing area. Among these, the topographic factors can be calculated from DEM data. Then, F_u can be estimated as follows:

$$F_u = \overline{W_u} \sin(\overline{S_u}) \overline{H_u} \sqrt{A_u} . \qquad (3)$$

Where, $\overline{W_u}$ is the weighting factor of the upslope contributing area, $\overline{S_u}$ is the average slope gradient of the upslope contributing area(°), $\overline{H_u}$ is the average relative altitude of the upslope contributing area (m), $\sqrt{A_u}$ is the size of the upslope contributing area (m^2).

1.2 The downslope component F_d

The downslope component F_d is used to describe the transport processes of the upslope sediment. F_d is strongly influenced by the flow pathway conditions, e.g. flow length, slope gradient along pathway, and surface materials along pathway. Hence, the upslope component F_d can be estimated as follows:

$$F_d = L\sum_i \frac{\cos(s_i)C_i}{w_{di}} . \qquad (4)$$

Where, L is the horizontal distance to river (m), w_{di} is the weighting factor of the i^{th} cell along the downslope path, s_i is the slope gradient of the the i^{th} cell (°), and C_i is length of the the i^{th} cell along the downslope path (m).

1.3 The weight factor W of the slope materials

In the Wenchuan Earthquake-hit area, the earthquake-induced landslides destroyed large areas of vegetation that made the vegetation hydrological adjusting function diminished, and the large amounts of unconsolidated loose materials deposited on the steep slopes that changed the hydrologic progresses (i.e. infiltration reduced, runoff increased and flow concentration expedited) in catchment(Cui et al., 2012). In addition, vegetation roots add strength to the slope materials by the vertically anchoring to fractures in the bedrock through the slope materials and by laterally binding the materials across potential zones of the failures(Endo and Tsuruta, 1969;Prandini et al., 1977). Therefore, the weight factor of the slope materials can be evaluated by monitoring the vegetation changes before and after the earthquake.

In practice, the slope materials stability susceptibility (w) model was trained through multivariate analysis of damaged vegetation and its survival environments in one given mountainous basin. And, the weight factor of upslope contributing area (W_u) can be simplified and expressed as the slope materials stability susceptibility (w), which is related to the sediment production. Then, the weight factor (w_{di}) along the downslope path can be calculated as ($\frac{1}{1-w}$).

2 Hydrological connectivity changes at the study area

The study area was divided into vegetation-covered and bare areas, the slope materials stability of the vegetation-covered areas were calculated basing on the multi-temproal NDVI images, and the bare areas were regarded as 1. Finally, pre-earthquake and post-earthquake *HCI* maps were calculated and shown in Fig.8. Results showed that the high *HCI* values are zonally distributed along both sides of the river, especially in YY and GY watersheds.

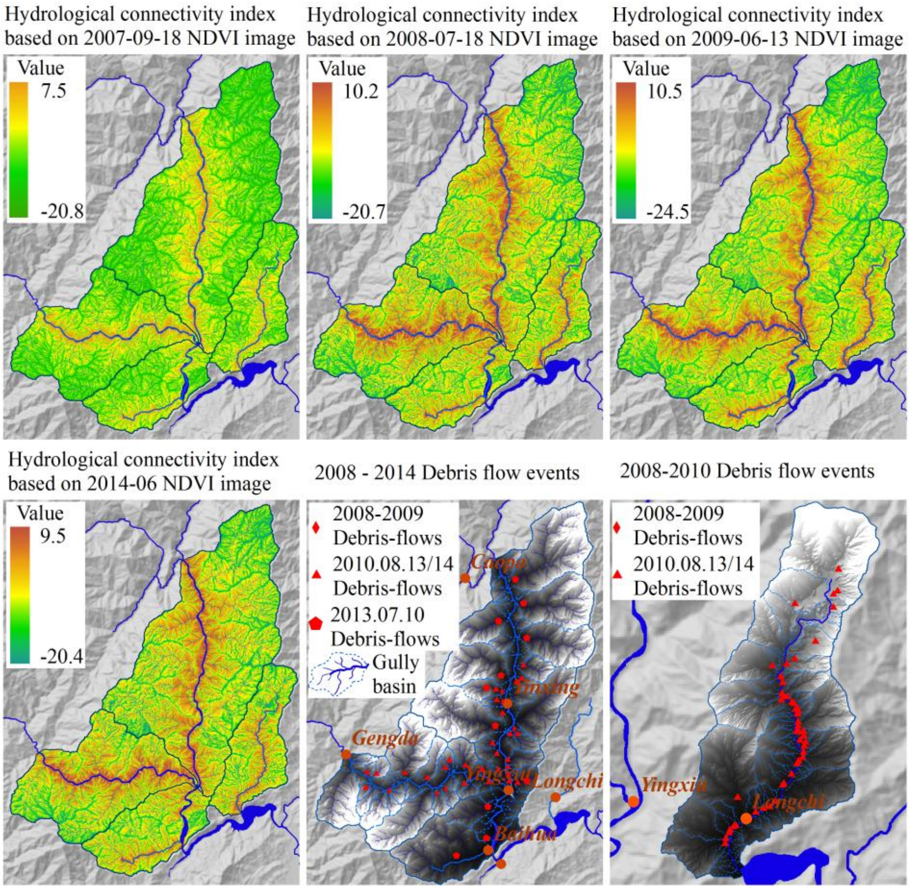

Figure 8. The hydrological connectivity index map and the 2008–2013 debris-flow events at the study area.

For further analysis, the multi-temporal *HCI* changes with *H* and *L* was shown in Fig.9. Statistical results indicated that the areas with *L* < 2 000m have obvious *HCI* increases (>1.00), which accounts for 37.2 % of the total areas, the areas with *H* < 500m have obvious increases (>1.00), which accounts for 32.5 % of the total areas, and the high mountainous areas with *H* > 2 500 m have obvious increases, too. Therefore, the areas with *H* < 500m and *L* < 2 000m have obvious increases (>1.00), which accounts for 27.9 % of the total areas, and *HCI* values have slowly decreases and no obvious changing trends with *L* and *H*.

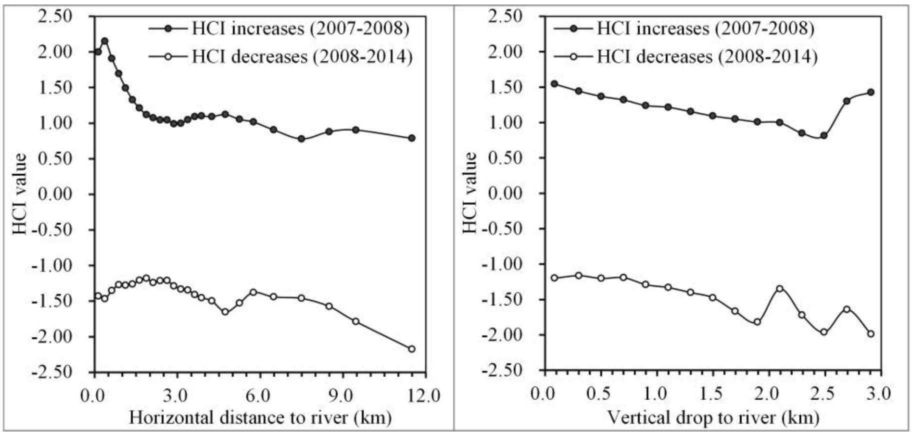

Figure 9. Statistical results of hydrological connectivity change processes from 2007 to 2014.

Since the earthquake, the study area had suffered severe debris-flow events (Fig.8). Statistical results showed that the areas with $H < 500$m and $L < 2\ 000$m account for about >35% of each debris flow gully area, and these areas have about obvious *HCI* increases and slower decreases with vegetation recovery. Therefore, we consider that the areas with $H < 500$m and $L < 2\ 000$m, hereafter called the "susceptible areas for debris flow formation, SADFF ", are more susceptible to the debris flow formation, and if the SADFF account more than 35% of the total gully area, the gully has high potential for debris flow in the wet season.

References

Borselli, L., Cassi, P., and Torri, D.: Prolegomena to sediment and flow connectivity in the landscape: A GIS and field numerical assessment, Catena, 75, 268-277, 10.1016/j.catena.2008.07.006, 2008.

Bracken, L., Wainwright, J., Ali, G., Tetzlaff, D., Smith, M., Reaney, S., and Roy, A.: Concepts of hydrological connectivity: Research approaches, pathways and future agendas, Earth-Science Reviews, 119, 17-34, 2013.

Bracken, L. J., Turnbull, L., Wainwright, J., and Bogaart, P.: Sediment connectivity: a framework for understanding sediment transfer at multiple scales, Earth Surface Processes and Landforms, 40, 177-188, 2014.

Brierley, G., Fryirs, K., and Jain, V.: Landscape connectivity: the geographic basis of geomorphic applications, Area, 38, 165-174, 2006.

Cavalli, M., Trevisani, S., Comiti, F., and Marchi, L.: Geomorphometric assessment of spatial sediment connectivity in small Alpine catchments, Geomorphology, 188, 31-41, 10.1016/j.geomorph.2012.05.007, 2013.

Fuller, I. C., and Marden, M.: Connectivity in steep-land environments: gully-fan coupling in the Tarndale system, Waipaoa catchment, New Zealand, IAHS-AISH publication, 275-282, 2008.

Fryirs, K., and Brierley, G. J.: Slope–channel decoupling in Wolumla catchment, New South Wales, Australia: the changing nature of sediment sources following European settlement, Catena, 35, 41-63, 1999.

Fryirs, K.: (Dis)Connectivity in catchment sediment cascades: a fresh look at the sediment delivery problem, Earth Surface Processes and Landforms, 38, 30-46, 10.1002/esp.3242, 2013.