Enhanced silicate weathering intensity in the mid-lower Changjiang (Yangtze River) valley in response to the Three Gorges Dam construction

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The Changjiang (Yangtze River), as the largest river system in Asia, is characterized by huge water and sediment discharges, but also by intense human activities. Despite the numerous investigations of weathering and erosion processes in this catchment, the complex sedimentary cycle, especially the buffering effect of large alluvial plain and the impact of the world's largest hydroelectric project (the Three Gorges Dam) are still poorly understood. Here, we report the temporal evolution of sediment chemistry in the mid-lower Changjiang mainstream and its major tributaries from the year 2003 (the beginning of TGD construction) to 2018, and aim to investigate floodplain weathering and whether the Three Gorges Dam (TGD) impoundment has significantly altered the river sediment chemistry.

The temporal changes of K/Si and Al/Si ratios, combined with hydrological data from major gauge stations, indicate a progressive increase of the sediment weathering degree (i.e. lower K/Si value) since 2003. Strong riverbed erosion occurred downstream the TGD, which changed the roles of local lakes and mid-lower reaches from important sinks to major sources of sediments delivered to the sea. Sediments collected downstream the TGD before 2003 exhibit weak weathering degree, in agreement with the overwhelming flux and fast transfer of the mountainous upper-reaches derived sediments, which makes it impossible to clearly observe the floodplain weathering signal. After the TGD construction, downstream riverbed erosion progressively disclosed the floodplain weathering signal. We estimate that about 23.2±2.5% of K was lost from the bulk sediments during their storage in the mid-lower floodplain and alluvial plains, accounting for the observed increase of weathering intensity after 2003. This study therefore provides the first observation and a deep insight into weathering and erosion processes in a large river system that is subjected to intensive human activities.