

LINKING LAND TO OCEAN: FLUX AND FATE OF WATER AND SEDIMENT
FROM THE YANGTZE RIVER TO THE EAST CHINA SEA

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ABSTRACT

Occupying a watershed of 1.8×10^6 km² and being home to >400 million people, the Yangtze River (Changjiang) is the largest river in southern Asia, annually discharging 900 km³ of water into the East China Sea (ECS). As a result, the flux and fate of the Yangtze's sediment, generally cited to be 480 million tons per year (mt/yr), have both scientific and societal relevance.

Although precipitation and runoff for the entire Yangtze watershed have changed little since 1950, the increase of runoff in Yangtze southern sub-basin has been much larger than that of precipitation, reflecting decreased temperatures and evapotranspiration. In contrast, the marked decreases in runoff in northern Yangtze have been due mainly to increased water consumption.

Since the 1980s, the Yangtze sediment load has declined dramatically, and 2004 loads at Yichang (just below the Three Gorges Dam - TGD) and Datong (lower stream) were only 12% and 33% of those in the 1950s and 60s, reflecting precipitation decline, landuse change, and most importantly, construction of >50,000 dams. Following the impoundment of the TGD, annual sediment load at Yichang dropped by 164 million tons (mt), but in the preceding 16 years it had decreased by ~300 mt/yr. Throughout the entire basin, the most significant sediment drops (>80%) occurred in two northern tributaries, one southern stream, and two passages between the mainstream and the shrinking Dongting Lake. Ongoing and proposed dams (collectively with greater storage capacity than the TGD) and north-south river diversions will probably decrease the Yangtze load to <100 mt/yr, thereby endangering the lower reaches of the river as well as the Yangtze delta.

Sediments on the inner shelf of the ECS reflect illite-dominated mud from the Yangtze River in the north as well as sandy silt and fine sand (low feldspar/quartz and low K-feldspar/plagioclase) from small mountainous rivers draining Taiwan to the south. Both sediments are significantly different from muds derived from the Yellow (smectite-rich) and Min (kaolinite-dominated) rivers. Grain-size distribution further confirms that ~25% of coarse sediments in northern Taiwan Strait (south of 26°N) are Taiwan-derived.

Along the inner shelf, an elongated (800 km) mud wedge, ~40 m thick at the 30-m isobath, overlies a transgressive sand layer; the mud wedge thins offshore to <2 m at the 80-m isobath. Four distinct acoustic facies can be delineated: late-Pleistocene, Transgressive System Tract (TST), and early and late High-Stand System Tracts (HST). The thin (<3m) and acoustically transparent TST is only located between 40- and 90-m isobaths south of 30°N. In contrast, early (2-11 ka BP) and late (0-2 ka BP, more opaque) sigmoidal HSTs are widely distributed in the inner shelf shallower than 70- and 50-m isobaths, respectively. Total volume of this Holocene mud wedge is 22×10^{11} m³, of which early and late HSTs account for 5.7 and 16.3×10^{11} m³, respectively. Assuming a density of 1.2 tons/m³, the average Yangtze sediment flux between 2 and 11 ka BP was 215 mt/yr, but increased to 330 mt/yr after 2 ka BP, primarily reflecting increased deforestation and agriculture. In the near future, however, extensive reforestation and dam construction may decrease the Yangtze load to less than half of its pre-anthropogenic level.