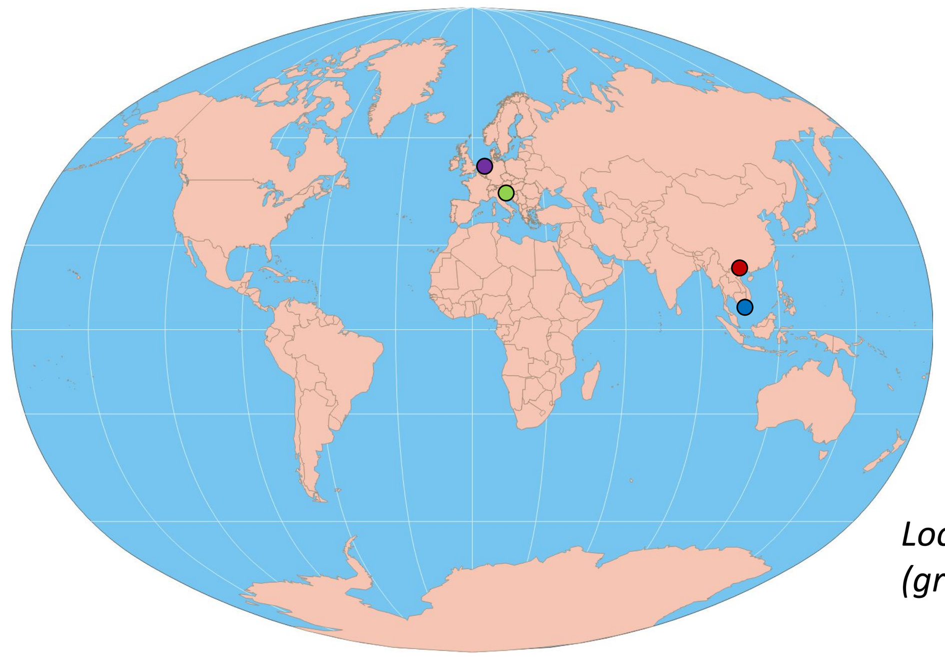
Landward translation of global deltaic shorelines during the last deglaciation: Implications for sediment partitioning

Melinda Quock & Torbjörn E. Törnqvist
Tulane University

Overview

The goal of this project is to systematically assess delta change in relation to delta size and morphology by means of shoreline trajectories. Shoreline trajectory traces the spatial shift of the average delta shoreline through time. It is widely recognized that at the end of the last deglaciation, deltaic shorelines generally transgressed well landward of the present-day shoreline before progradation commenced, largely associated with the rapid deceleration of global sea-level rise around 7,000 years ago. Here, we present a preliminary synthesis of selected deltas based on available information. These deltas have abundant previously constructed paleogeographic maps or sequence-stratigraphic records. Their shoreline positions over time since the last deglaciation have been plotted as well as combined in a preliminary scaled comparison.

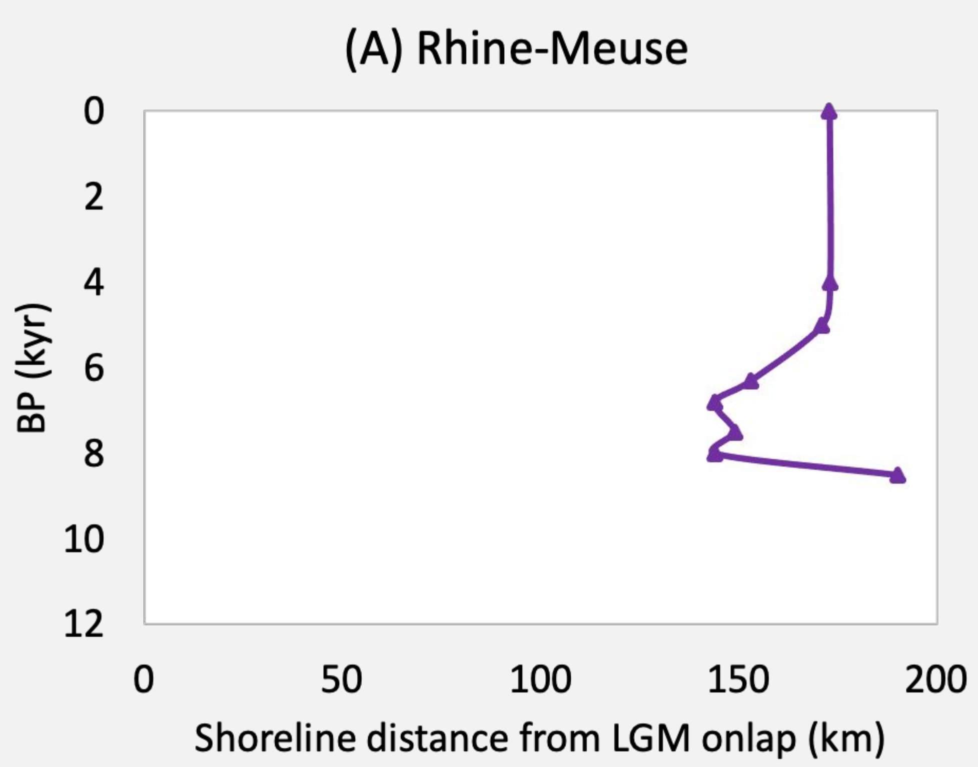


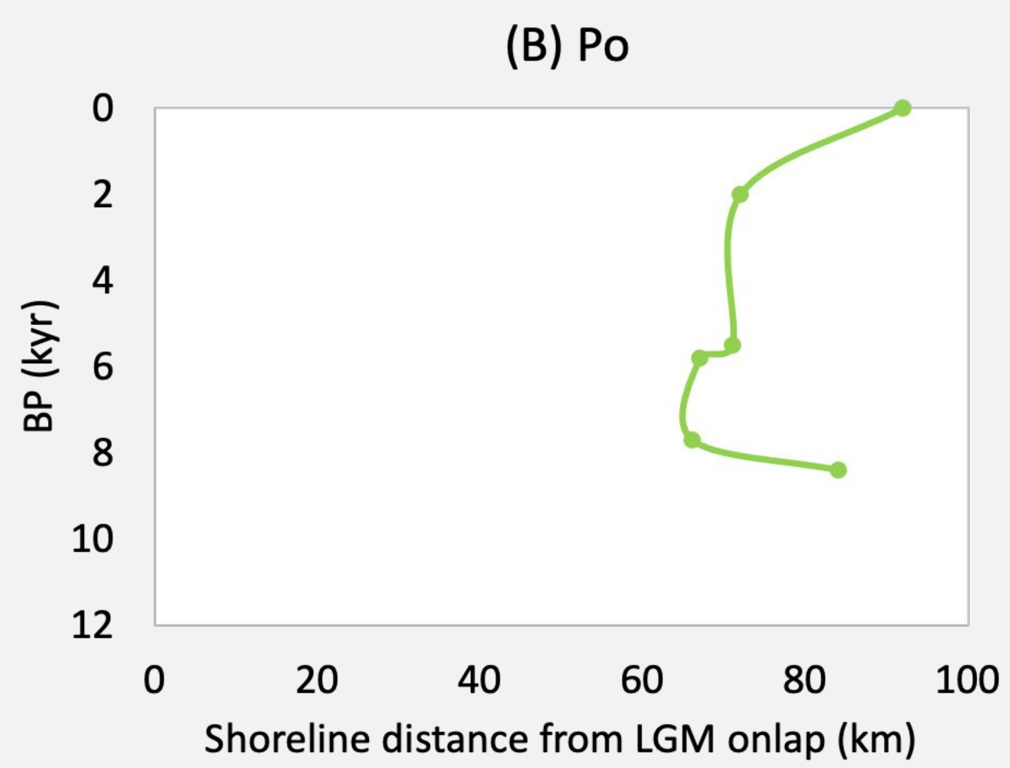
Location map of the Rhine-Meuse (purple). Po (green), Mekong (blue), and Red River (red) deltas.

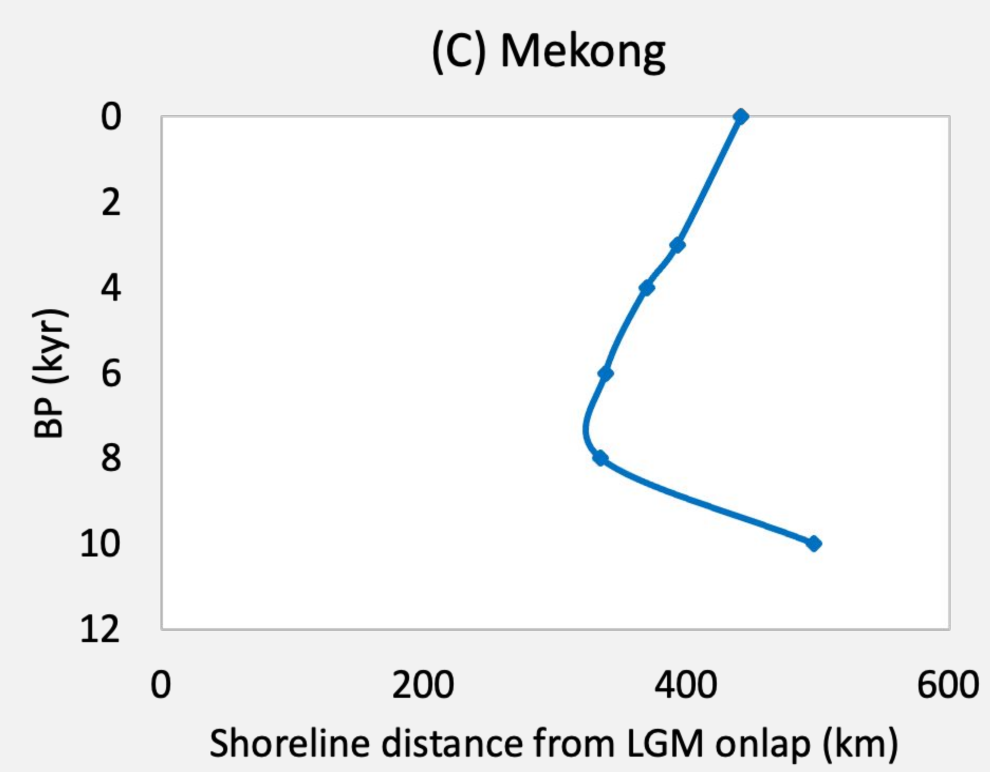
Delta	Catchment Area (km²)	Delta Plain Area (km²)	Dominant Morphological Process
Rhine-Meuse	220,000	2,600	Tide-dominated
Po	74,500	400	Wave-dominated
Mekong	795,000	62,520	Tide-dominated
Red River	169,000	5,600	Tide-dominated

Area and dominated morphological processes of the deltas

Fig. A-D: Shoreline distances from the LGM onlap throughout the Holocene for selected deltas derived from sequence stratigraphy and/or constructed paleogeographic maps. (a) Rhine-Meuse, 8.5 – 0 kyr (Hijma & Cohen, 2011; Berendsen & Stouthamer, 2002); (b) Po, 8.4 – 0 kyr (Bruno et al., 2017); (c) Mekong, 10 – 0 kyr (Ta et al., 2021; Nguyen et al., 2000); (d) Red River, 10.5 – 0 kyr (Duong et al., 2020).







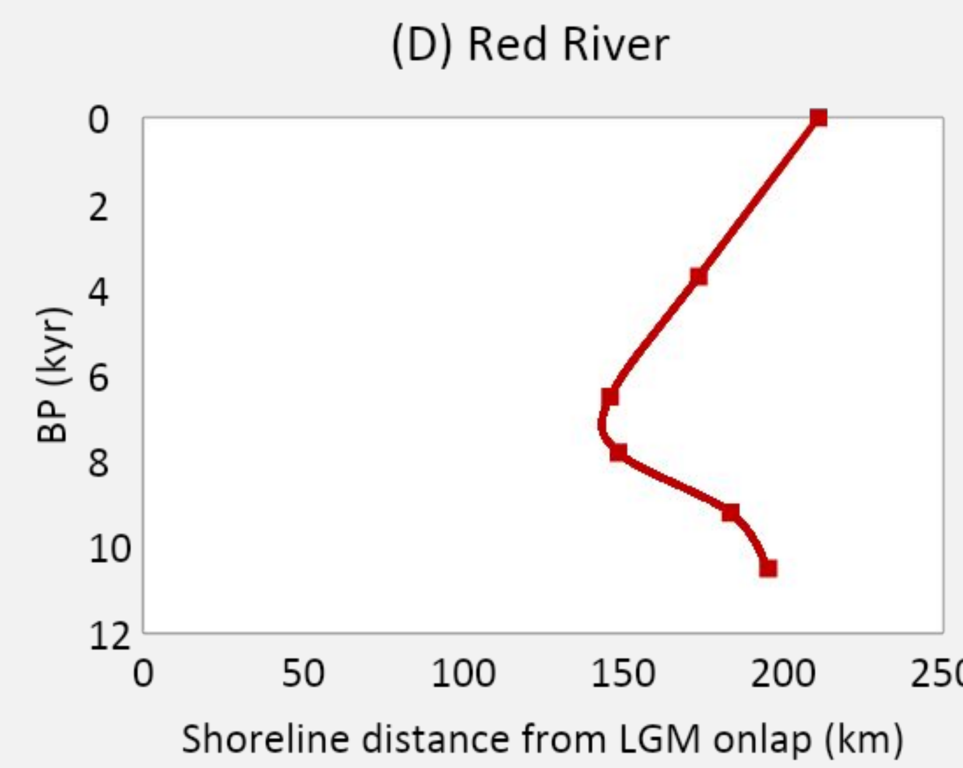
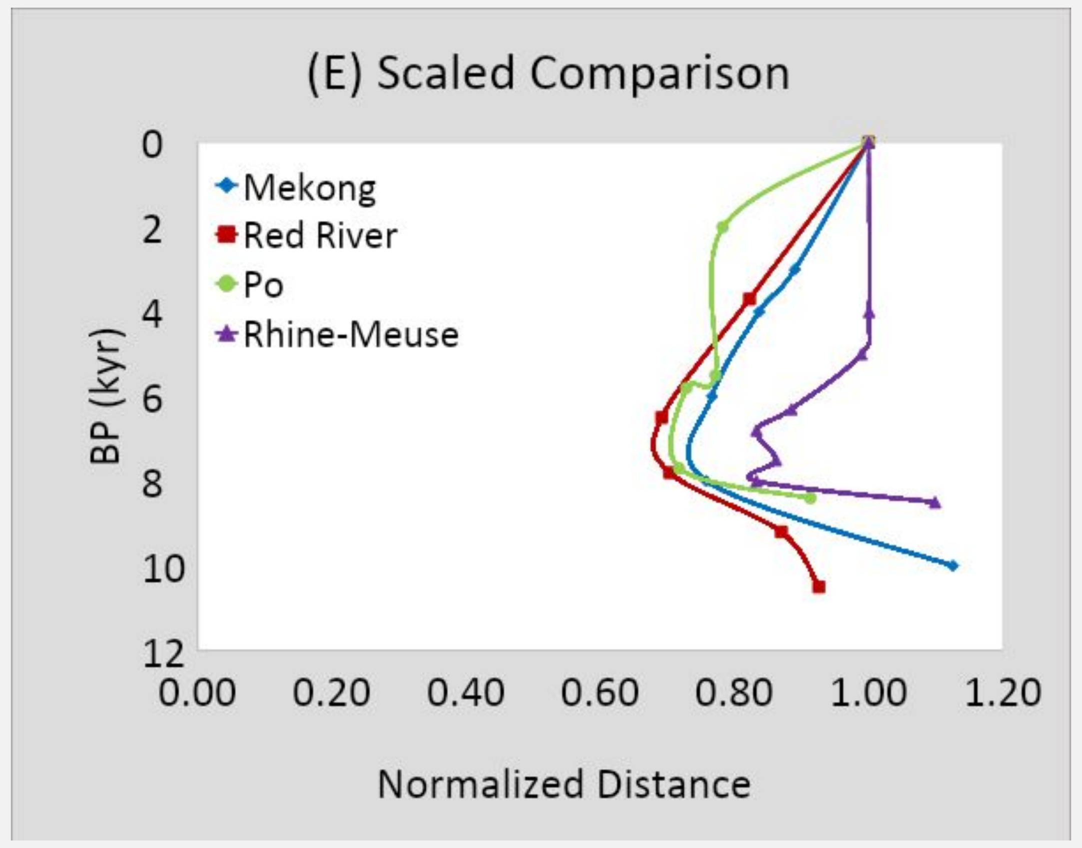


Fig. E: The Rhine-Meuse, Po, and Red River delta shoreline distances to the LGM onlap position were scaled as a ratio where 0 is the LGM onlap point and 1 is the modern shoreline position (for each delta).



Methods

LGM Onlap Position

- This is the position where the LGM floodplain surface intersects the modern-day floodplain. This position is then used as the reference point for shoreline position.

Shoreline Position

- Delta paleoshorelines were determined from existing interpretations of available sequence stratigraphy and/or paleogeographic maps
- Location of the modern-day shoreline (0 kyr BP) was determined using satellite imagery from Google Earth Pro.

Scaled Comparison

- The shoreline distances of each delta was scaled as a fraction of the delta's present-day (0 kyr BP) shoreline distance.

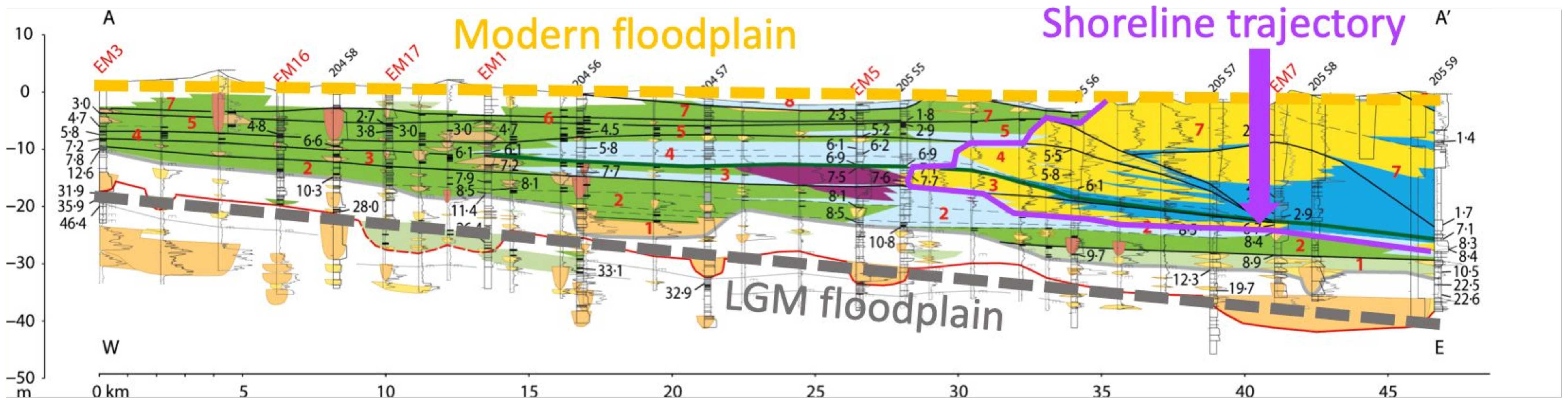


Figure to the left displays an example of shoreline trajectory interpretation overlaying a sequence stratigraphic record of the Po Delta from Fig. 2 of Bruno, et al. (2017).

Results

- The shoreline of maximum transgression of all the deltas occurs around 8 – 6 kyr BP.
- The Mekong and Red River Deltas display the simplest shoreline trajectories in terms of linearity in sections before and after maximum transgression.
- After scaling, the position of the Rhine-Meuse delta shoreline is proportionally the farthest from its LGM onlap point.
- The Rhine-Meuse delta has the smallest range of change in shoreline distances.

Future Work

To further analyze shoreline trajectories of deltas:

- Shoreline trajectory analyses will continue for other deltas with sufficient available information.
- Multiple shoreline trajectories corresponding to different transects for each delta will be plotted.
- Comparisons will be made based on dominant morphological processes, delta size, and other factors in the geologic setting.
- Roles of sediment supply (especially those with very high and very low supply) and local sea level will be examined.

Implications of shoreline position include:

- Partitioning of sediment (i.e., sediment retention) between the delta top and delta front.
  - This leads to more precise calculations of sediment volume.

References:
Hijma & Cohen, K. M. (2011). *Sedimentology*, *58*(6), 1453–1485.
Berendsen, & Stouthamer, E. (2002). *Geologie En Mijnbouw*, *81*(1), 97–112.
Ta, et al. (2021). *Marine Geology*, *433*, 106406–.
Nguyen, et al. (2000). *Journal of Asian Earth Sciences*, *18*(4), 427–439.
Duong, et al. (2020). *Review of Palaeobotany and Palynology*, *278*, 104235–.
Bruno, et al. (2017). *Sedimentology*, *64*(7), 1792–1816.

Tulane University