

Appendix A: Hydrological Modelling and Geospatial Data

This appendix provides the complete workflow and data sources used for hydrological modelling and geospatial validation of floodplain extents discussed in Section 1 of Methodology (*Palaeo-Nile Flow Reconstruction and Monument Accessibility*).

A.1 Geospatial Reference Points for Giza Functional Hydrological Interfaces

Structure (Functional Reference Point)	Latitude (°N)	Longitude (°E)	Elevation (m)	Source / Notes
Khufu Causeway Terminus	29.9785	31.1400	60.1	Inferred from Nazlet el-Samman slope
KVT	29.972565	31.137768	22.5	Preserved, U-shaped harbour basin evident
Menkaure Causeway Terminus	29.9721	31.1357	39.4	Estimated from slope and causeway remnant

- Geolocated using Google Earth Pro v7.3.6 and cross-validated with archaeological surveys (1,2), clipped to a 10km Giza extent.

A.2 Elevation Model and Hydrological Data

- **DEM Source:** NASA SRTM 1-arc second (approximately 30 m resolution)
- **Software:** QGIS 3.36, GRASS GIS 8.3
- **Processing:**
 - Sink filling: r.fill.dir
 - Watershed delineation: r.watershed (threshold: 1,000,000 m²)
 - Stream edge detection: r.stream.basins
 - Euclidean distance computation: r.grow.distance
 - Flood simulation: r.lake (levels approximating 63 m highstand and 50 m regression)

- **Epochs:**
 - 4400±200 BCE: Holocene highstand (approximately 63 m) (1)
 - 2500±30 BCE: Old Kingdom regression (approximately 50 m) (3)
- **Error Bounds:**
 - DEM vertical uncertainty: ±0.5 m
 - Lateral boundary error: ~30–50 m (impacting flood boundary precision)

A.3 Hydrological Accessibility and U-Shaped Basin Analysis

The U-shaped harbour basin of KVT, potentially an unloading dock, was assessed for fluvial accessibility:

- At ~63m (4400±200 BCE highstand), the basin is fully inundated (0 m to floodplain), enabling direct barge docking.
- At ~50m (2500±30 BCE regression), the basin is >90 m from the floodplain, requiring portage.
- Khufu Causeway Terminus (60.1 m) and Menkaure Causeway Terminus (39.4 m) show direct access (15 m and 38 m) at 63m, with portage at 50m.

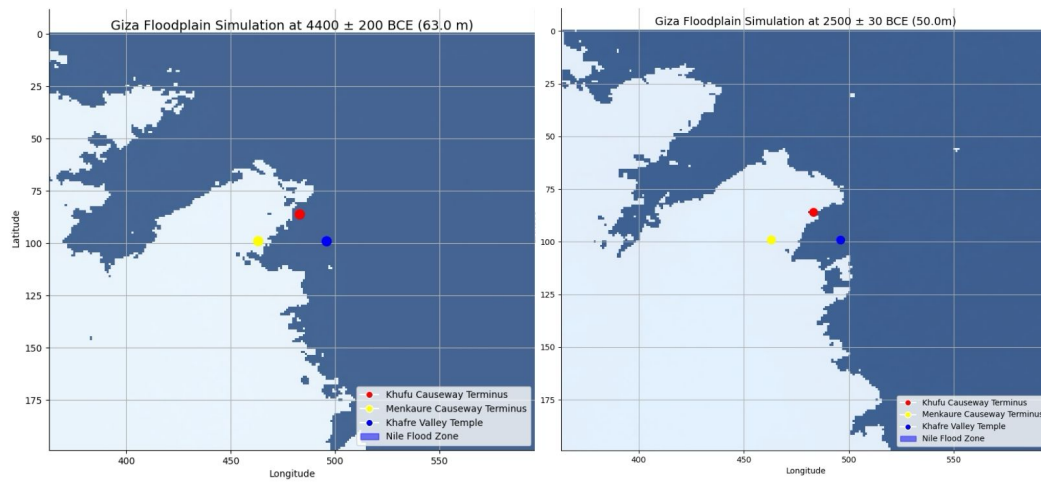
These accessibility thresholds provide the quantitative foundation for the hydraulic reconstruction presented in Appendix J, linking mid-Holocene inundation levels to the architectural configuration of the KVT.

Accessibility Classification:

- ≤ 50 m: Direct Access (suitable for docking or barge transfer)
- 50–300 m: Short Portage (possible but logistically constrained)
- ≥ 300 m: Isolated (no practical fluvial access)

Fig. 1 illustrates the reconstructed hydrological maps, and Table A1 summarises distance data.

Figure 1. Simulated Floodplain Extents at Giza for 4400 ± 200 BCE and 2500 ± 30 BCE Nile Levels



Note: DEM-based floodplain modelling shows that KVT lies directly within the inundated zone, consistent with potential harbour use. In contrast, Khufu's causeway terminus stands ~185.5 m inland, while Menkaure's is closer at ~111.5 m but appears farther on the map due to topographic slope orientation. Full modelling workflow is described in Appendix C.7.

References

1. Kuper R, Kröpelin S. 2006. _Climate-controlled Holocene Occupation in the Sahara: Motor of Africa's Evolution. Science 313, 803–807.
2. Lehner M. 1997. _The Complete Pyramids: Solving the Ancient Mysteries._ Thames & Hudson, London.
3. Butzer K W. 1976. _Early Hydraulic Civilization in Egypt._ University of Chicago Press, Chicago.