

## Supplemental Material

### 1-Hazipur Well

The boundary at 244 m depth in the 1960 Hazipur-1 well is ascribed to the top of the Dupi Tila Fm and overlain by undated Recent-subrecent deposits (Loske and Teigler, 2013). However, formations in the prograding GBD are very time transgressive (Najman et al., 2012). Najman et al. (2012) propose a seismic stratigraphy in which the base of Megasequence 3, generally corresponding to the “recent” deposits, is 0.4-1.9 Ma. The boundary that Alam (1996) note is corresponds to a dominantly clay to a dominantly sand transition (Loske and Teigler, 2013). This is likely a shift to more proximal deposits or a shift in fluvial pathways and cannot be confidently correlated to the base of the Holocene. Shallow seismic imaging and tube well sampling (Pickering et al., 2018; Grall et al., 2018) indicate the base of the Holocene at the well, which lies in the Brahmaputra incised lowstand valley, should be about 60 m below sea level. The Hazipur-1 well is situated slightly landward of the Hinge Zone (Fig. 1) where limited subsidence is expected and reworking of the deposits can easily produce a lithologic transition at ages before the beginning of the Holocene. We thus consider this date to be unreliable.

### 2- Table S1: Summary of papers on subsidence discussed in text

Full listing of all individual measurements up to 2015 can be found in Brown and Nichols (2015)

Source	Area	Timescale	Methods	Subsidence Rates (subsidence +ve)
Alam (1996)	Throughout Bangladesh and West Bengal	Millennial	Summary of earlier data; Radiocarbon ages; Hydrocarbon well stratigraphy	-0.3 to 4 mm/y 22 mm/y
Hoque and Alam (1997)	Throughout Bangladesh and West Bengal	Millennial	Summary of earlier data; Estimated tectonic subsidence (multiple methods) Peat and wood assumed 5000y age	0.1 to 3.35 mm/y + 21 mm/y (Sylhet) 0.24-5.48 mm/y
Allison et al. (2003)	Lower Delta Plain, Bangladesh	Millennial	Radiocarbon dates; 5 previously published dates 7 new dates	0.52-7.12 mm/y Average = 2.18 mm/y
Grall et al. (2018)	Throughout Bangladesh	Millennial	Radiocarbon dates on tube well samples over Holocene	0 to 4.5 mm/y
Ericson et al. (2006)	Global	Millennial, Decadal,	Rates from Alam (1996) and Haq (1997) who estimates 10-25 mm/y (4 mm/y natural + 13 mm/y water withdrawal)	Up to 25 mm/y
Brown and Nichols (2015)	Throughout Bangladesh and West Bengal	All Scales: Millennial, Centennial, Decadal	Compilation of 203 rates from 24 papers. Methods include archeology, wells, radiocarbon, geomorphology, GNSS, groundwater levels, InSAR, neotectonics, magnetostratigraphy, tank excavation	-1 to 44 mmy mean 5.6 mm/y median 2.9 mm/y; Rates decrease with increasing time interval
Sarker et al. (2012)	SW Bangladesh	Centennial	Relative plinth elevation	-0.6 to 2.5 mm/y

Hanebuth et al. (2013)	Katka in Sundarbans	Centennial	Elevation relative to modern land level with 6 radiocarbon and 7 OSL dates	$4.1 \pm 1.1$ mm/y
Syvitski et al. (2009)	Global	Decadal	Tides gauges from PSMSL; average rate 8.35 mm/y high rate at Khepupara 18 mm/y	8-18 mm/y
Ostanciaux et al. (2012)	Global	Decadal	Tides gauges from PSMSL; 5 sites India (-3.65 mm/y) 2 sites Bangladesh (Hiron Point, Khepupara; 12.33 mm/y)	-3.56 and 12.33 mm/y
Higgins et al. (2014)	Swath from north of Dhaka to Noakhali	Decadal	ALOS-1 InSAR for 2007-2011; Calibrated with GNSS	0 to 18 mm/y
Reitz et al. (2015)	Throughout Bangladesh	Decadal	18 GNSS with 3 in coastal zone; time series from 2003 or 2007 to 2013	3 to 8 mm/y in coastal zone
Becker et al. (2020)	Throughout Bangladesh and West Bengal	Decadal	Analysis of groups of tide gauges for subsidence	Expected maximum subsidence of 1.5 to 7.2 mm/y for different regions

### 3-Shakher Temple

Sarker et al. (2012) describes the temple as “the only standing ancient structure in the Sundarbans is located in Shakher Tek, about one kilometer away from the east bank of the Sibsa River. In the early 17th century, Raja Paratapaditya had established a township and a fort there during his reign in order to fend off Arakanese and Portuguese pirates. The temple itself was built by the Pratapaditya settlers. It is located in Dacope upazila of Khulna district. Made of brickwork, the temple is a temple for the goddess Kali of the Hindu religion.”

Paratapaditya was the last Hindu King of Jessore until his defeat by the Mughals in 1611. He ascended the throne in 1584. He built multiple forts including ones in the Sundarbans. The time of construction of the Shakher temple and the nearby fort is not known, but they were possibly built after 1602, when the Arakanese took control of Sandwip Island. It is worth noting that in the Rennell map of 1776 (Fig. S1), there is a split of the Murjuttah River (current Sibsa River) into multiple channels near where the fort and temple are. The fort and temple were likely built along the main channel on the natural levee of the island to control the channel, rather than 1 km inland from it as they are now.

We interpret the plinth level as being at a ridge at the base of the stairs (Fig. 6). This ridge is found around all sides of the temple. Furthermore, this position is consistent with the augering conducted by S. Goodbred and D. Mondal at the temple where they encountered a brick layer (Fig. S2) whose base we interpret as the original TPL level minus any excavation for preparing and leveling the site for construction. The depth of the base of the brick layer was at  $1.5 \pm 0.1$  m below the surface.

The temple was likely built on the levee of the island to further protect against flooding, but is now in the interior. In the calculations 0.2 m is added to the subsidence to account for the change in ground surface. This is based on the GPS elevation data in Auerbach et al. (2015) showing a dropoff in elevation of this amount in the Sundarbans away from the channel.

We calculate the subsidence based on the elevation of the various reference layers and the depth to the base of the brick layer. In the calculations, we follow the Sarker et al. (2012) estimate of 0.25 m of relative sea level rise since the temple was built. This is subtracted off the RSLR to get the subsidence rate. We estimate the plinth level as 0.1 m above TPL level from our photos. We estimate original surface excavated by ~0.1 m to remove mud and plants and level ground.

Using Sarker et al. (2012) method (Figure 5)

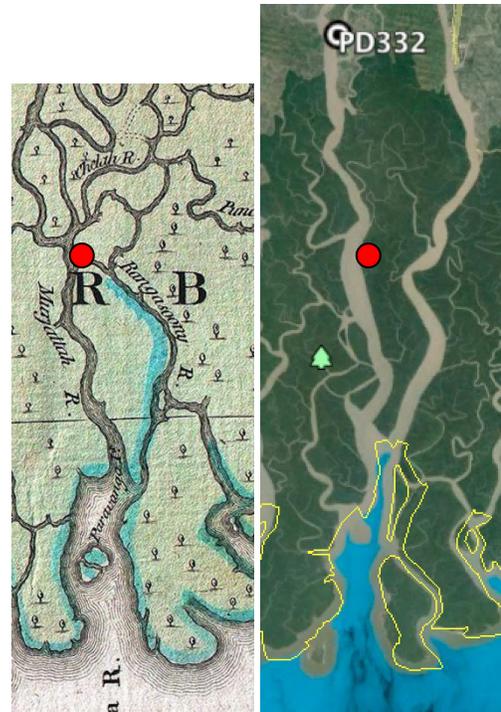
Original Plinth (PLS) = TPL + (1.2 to 1.8 m) (augering yielded 1.6 m)

Current Plinth (PLE) = TPL + 0.1 m

Subsidence = PLS - PLE + Levee - Excavation - SLR

Subsidence = (1.2 to 1.8) - 0.1 + 0.2 - 0.1 - 0.25 = .95 to 1.55 m

at 400 y = **2.4 mm/y to 3.9 mm/y** (for augering result = **3.4 mm/y**).



**Figure S1.** Comparison of segment of Rennell (1776) map and Google Earth image in the vicinity of the temple (red dot).



**Figure S2.** Dhiman Mondal and others examine the auger, which contains a piece of brick.

#### Determination using auger results

Current base of bricks = TPL -  $1.5 \pm 0.1$  m

Subsidence = (TPL - Bricks) + Levee - SLR - Excavation

Subsidence =  $1.5 + 0.2 - 0.25 - 0.1 = 1.35$  m

at 400 y = **3.4 mm/y**  $\pm 0.25$  mm/y

or

#### Using Absolute elevations

Original TPL = 2.6 m (MHW from Auerbach et al. (2015))

Current TPL = 2.4 m (Fast static GPS result from Auerbach et al. (2015))

Current plinth =  $2.4 - 1.5 = 0.9$  m

Subsidence = OTPL - CTPL - SLR - Excavation

Subsidence =  $2.6 - 0.9 - 0.25 - 0.1$  m = 1.35 m

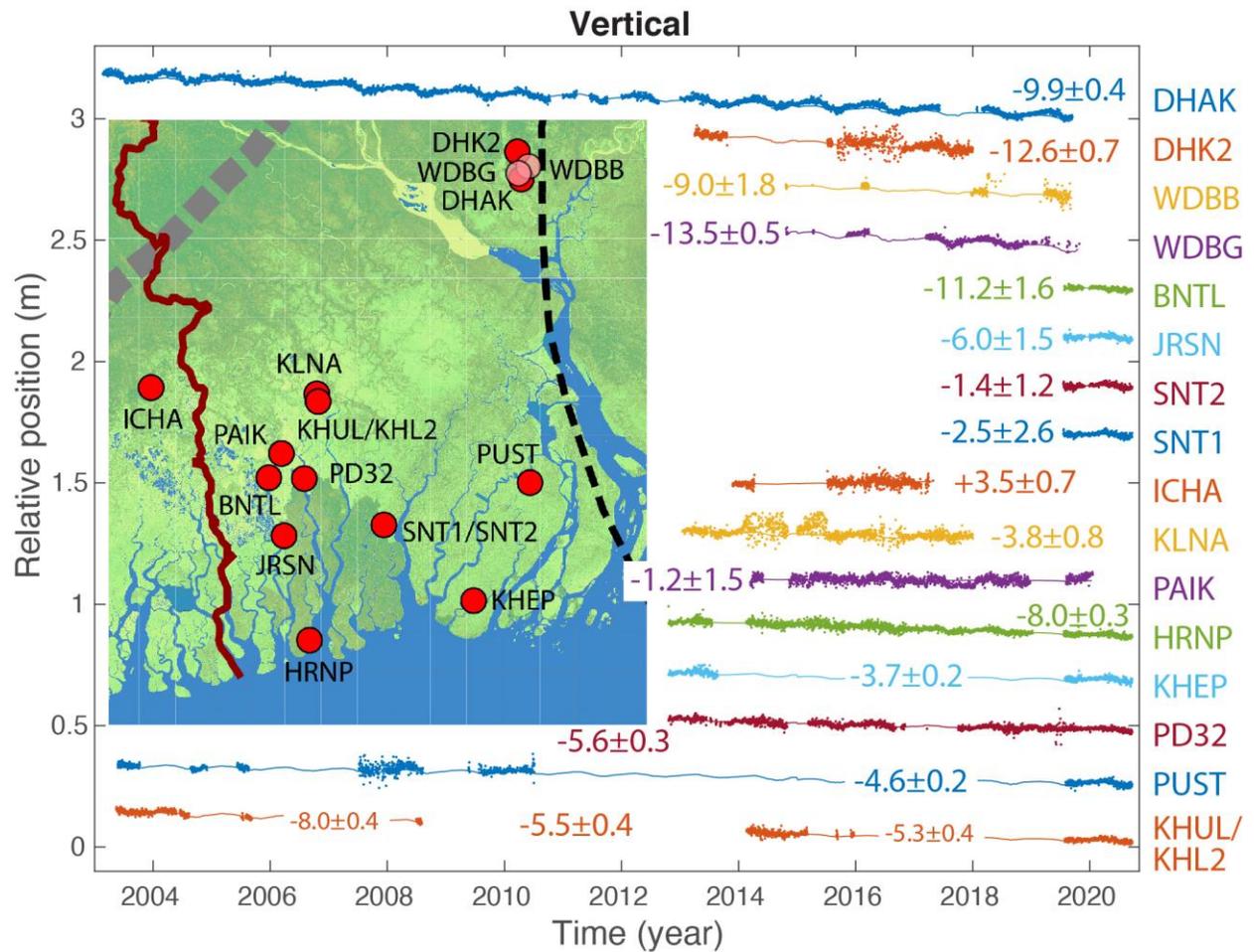
at 400 y = **3.4 mm/y**  $\pm 0.25$  mm/y

The result is that estimates range from ~2.4-3.9 mm/y. If the observed elevation difference between the bricks and the plinth is used, the estimates are all  $3.4 \pm 0.5$  mm/y. These estimates are not independent, but are consistent. It is lower if you do not assume that the temple was built on the island levee. The levee height of 0.2 m is equal to the observed elevation changes for the Sundarbans in the Auerbach et al. (2015) GPS survey. The interior elevation for the ground height at the temple is from a measurement during the same GPS survey, with the base stations 30 km to the north at PD32 (Figure S1).

#### **4- Geodesy in GBD**

GNSS systems have been used to examine tectonics of the IndoBurma subduction zone (e.g., Steckler et al., 2016, Mallick et al., 2019) and the Shillong Plateau (Mallick et al., 2020). Results indicate 13-17 mm/y of active eastward subduction across the IndoBurma subduction zone (Steckler et al., 2016, Mallick et al., 2019). However, Panda et al. (2020) suggest convergence is only 7-10 mm/y by referencing the motion to the stable Sunda block to the SE, rather than the Shan Plateau directly to the east. The Shillong Massif is rotating clockwise and overthrusting the Bengal Basin at rates reaching 5-8 mm/y in the eastern part of the plateau (Mallick et al., 2020). While these studies focused on the horizontal components of the velocity, the models predict 3-4 mm/y of subsidence from elastic loading and similar amounts of uplift farther east and north (Oryan et al., 2020). Reitz et al. (2015) examined the vertical component of GPS throughout Bangladesh for regional patterns and found both subsidence and uplift in the foldbelt reaching 7 mm/y. We have reprocessed all available data. Here we present subsidence rates for stations in southwestern Bangladesh. Figure S3 show the time series for all the stations in southwestern Bangladesh with the modeled subsidence, including seasonal corrections shown as thin lines. Values and locations for the stations are provided in Table S1.

Two of the sites with the longest records, PUST and KHUL/KHL2 had their original, intermittently working, outdated systems replaced. For PUST, a Trimble 400ssi was replaced with a Septentrio PolaRx5 in 2019 using the same antenna mount. For KHUL, a Trimble 400ssi was replaced with a Trimble NetR9 in 2014. The new antenna, KHL2, is ~200 m farther west.



**Figure S3.** Vertical position time series for all of stations used in this paper. Colored dots and curves denoted daily GNSS measurement and long-term fitted behaviour for each station, respectively. We assigned an arbitrary constant shift to aid in visualization. The map shows the labelled position of each station.

**Table S2:** Locations and rates of subsidence measurements, along and installer and time span.

Site	Installer	Latitude	Longitude	Vertical Rate $\pm$	Years	No. Points
DHAK	LDEO/DUEO	23.7267	90.4013	-9.94 $\pm$ 0.35	16.56	5249
DHK2	EOS	23.8047	90.3879	12.55 $\pm$ 0.69	4.75	1006
WDBB	LDEO/DUEO	23.7887	90.4115	-9.02 $\pm$ 1.83	4.91	319
WDBG	LDEO/DUEO	23.7529	90.3883	-13.49 $\pm$ 0.51	5.01	792
BNTL	LDEO/BWDB	22.4981	89.2301	-11.16 $\pm$ 1.56	1.53	505
JRSN	LDEO/BWDB	22.2480	89.3445	-6.06 $\pm$ 1.46	1.53	525
SNT2	LDEO/BWDB	22.2556	89.8055	-1.43 $\pm$ 1.18	1.54	533
SNT1	LDEO/BWDB	22.2522	89.8051	-2.46 $\pm$ 2.55	1.54	553
ICHA	EOS	22.8999	88.7360	3.47 $\pm$ 0.69	3.42	744
KLNA	EOS	22.8526	89.5313	-3.79 $\pm$ 0.83	4.96	1639
PAIK	BanD-Aid	22.5848	89.3194	-1.21 $\pm$ 1.50	5.85	1654
HRNP	LDEO/DUEO	21.8164	89.4594	-8.03 $\pm$ 0.27	8.16	2503
KHEP	LDEO/DUEO	21.9867	90.2197	-3.65 $\pm$ 0.17	8.28	840
PD32	LDEO/DUEO	22.5046	89.4359	-5.63 $\pm$ 0.34	8.29	2298
PUST	LDEO/DUEO	22.4650	90.3833	-4.60 $\pm$ 0.16	17.70	1457
KHUL/KHL2	LDEO/DUEO	22.8028/22.8021	89.5345/89.5327	-5.53 $\pm$ 0.35	17.72	1447
KHLC	BanglaPIRE*	22.6717	89.5694	9 $\pm$ 1	4.95	136-224
PD32 RSET	LSU	22.4520	89.4840	9.7 $\pm$ 1.6	5	11
Shakher Temple		22.22	89.50	3.4 $\pm$ 0.5	~400	2

LDEO = Lamont Doherty Earth Observatory

DUEO=Dhaka University Earth Observatory

BWDB=Bangladesh Water Development Board

BanD-Aid = Bangladesh Delta: Assessment of the Causes of Sea-level Rise Hazards and Integrated Development of Predictive Modeling Towards Mitigation and Adaptation

<http://belmont-bandaaid.org>

EOS=Earth Observatory of Singapore

BanglaPIRE= PIRE: Life on a Tectonically-Active Delta: Convergence of Earth Science and Geohazard Research in Bangladesh with Education and Capacity Building

<http://www.banglapire.org>

<https://www.researchgate.net/project/BanglaPIRE-Life-on-a-Tectonically-Active-Delta>

LSU = Louisiana State University

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