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Supplementary Information for

Water level changes, subsidence and sea level rise in the Ganges-Brahmaputra-Meghna delta

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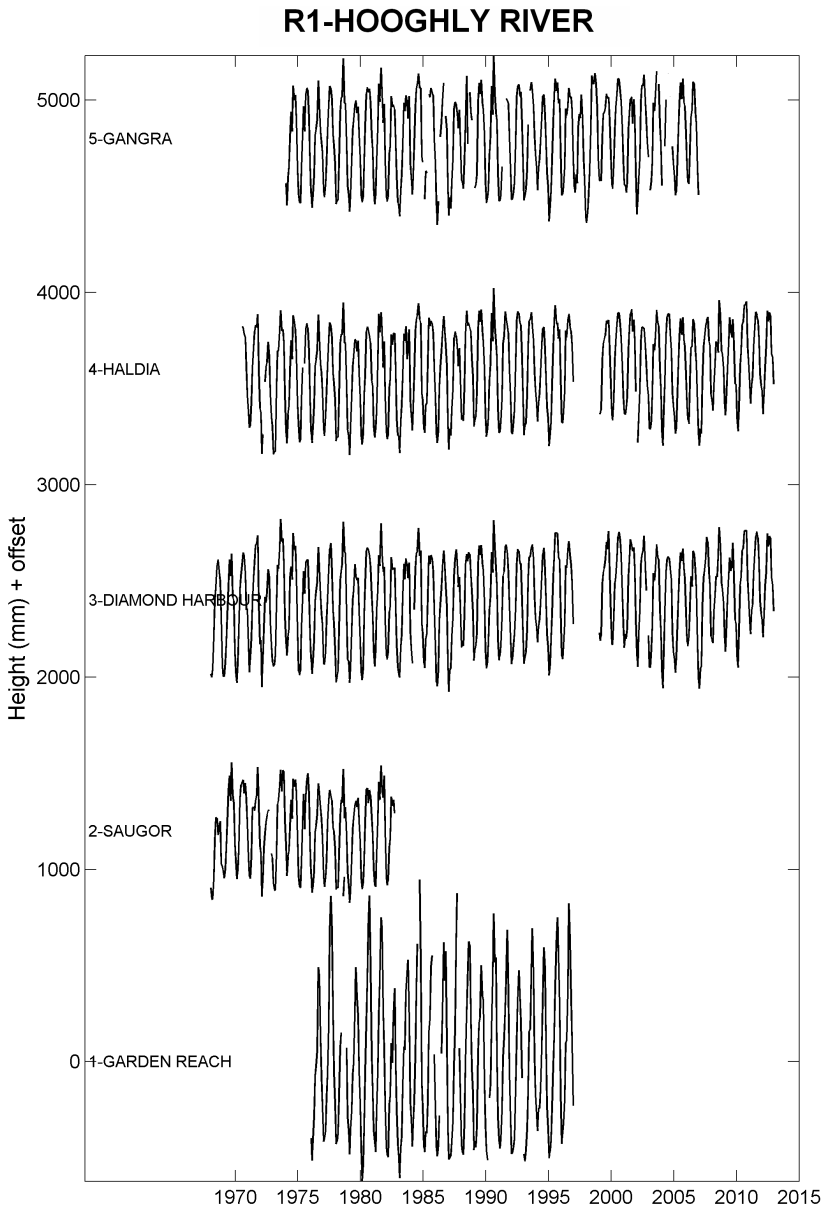

Fig. S1a. Water level gauges time series from the Region 1 - Hooghly River.

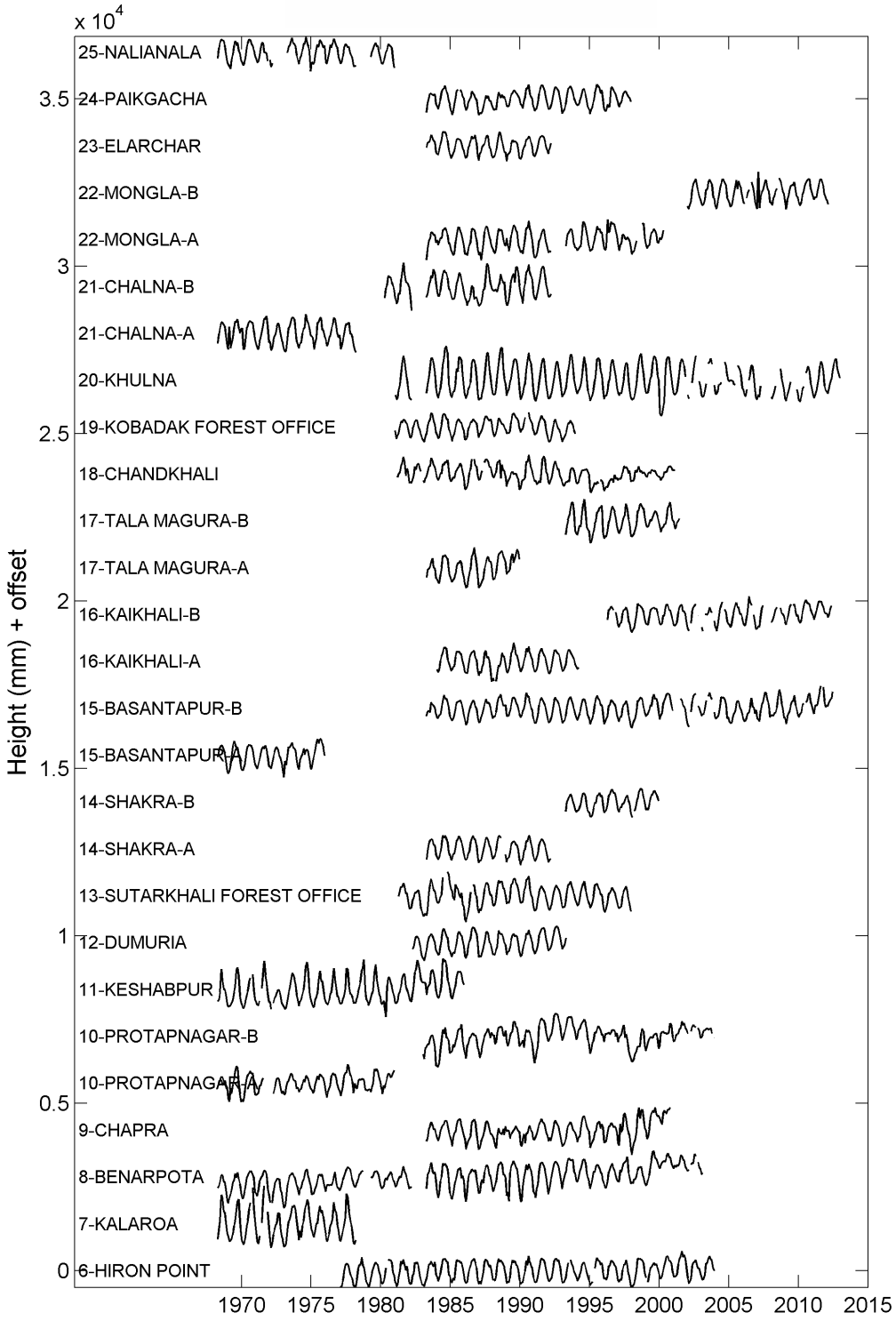

Fig. S1b. Water level gauges time series from the Region 2 - Ganges tidal floodplain/ Sundarbans.

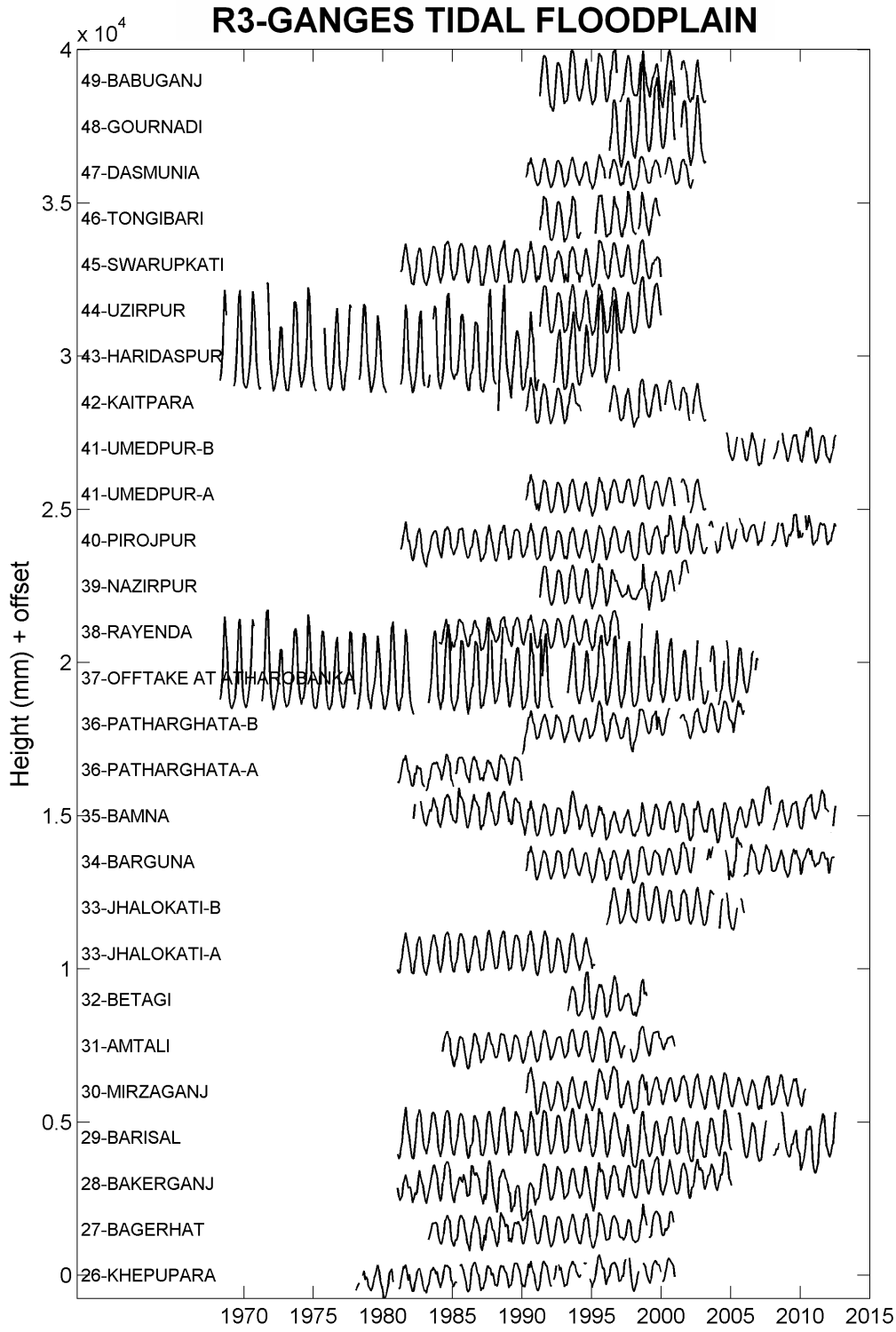

Fig. S1c. Water level gauges time series from the Region 3 - Ganges tidal floodplain.

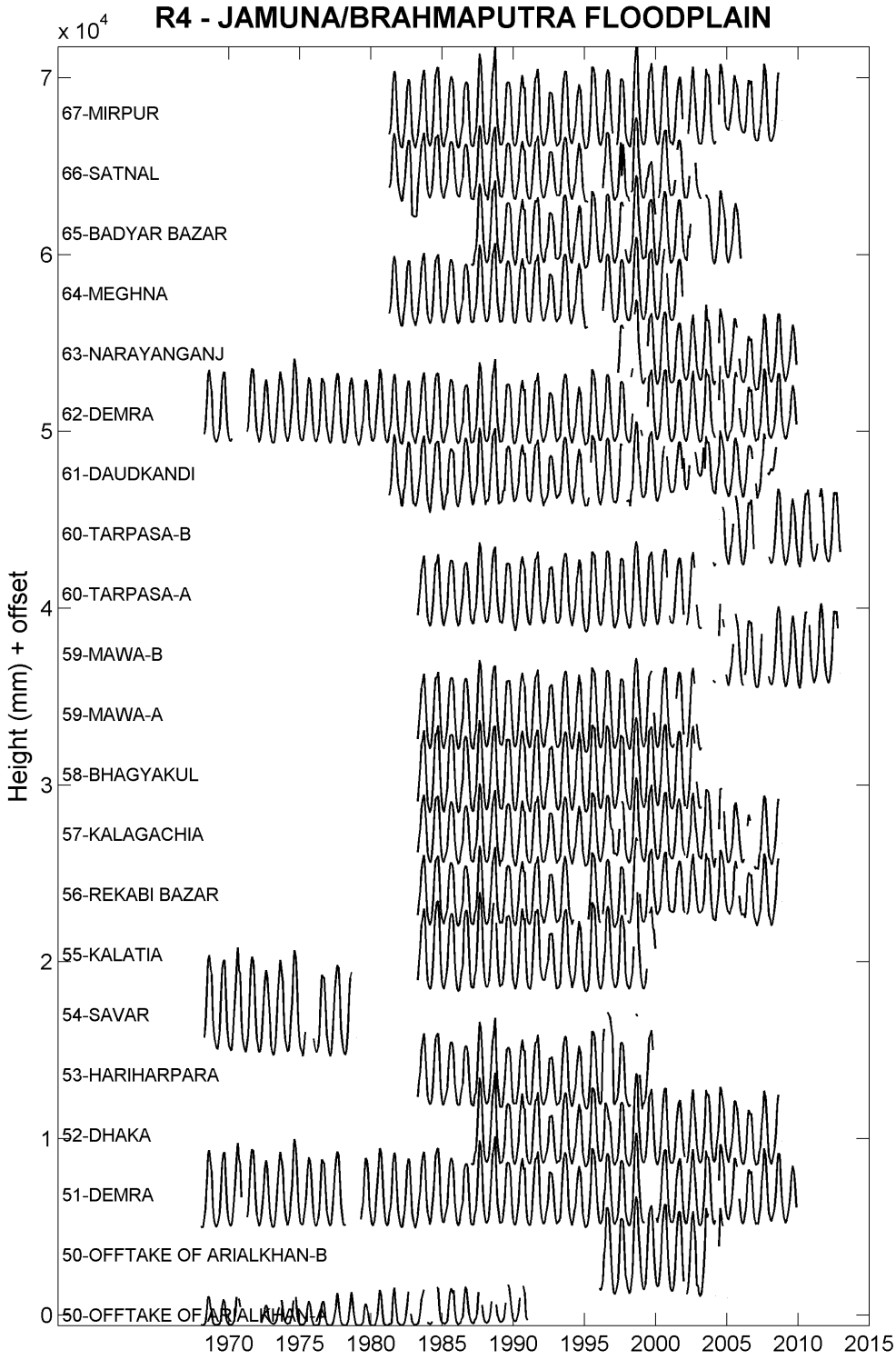

Fig. S1d. Water level gauges time series from the Region 4 - Jamuna/Brahmaputra floodplain.

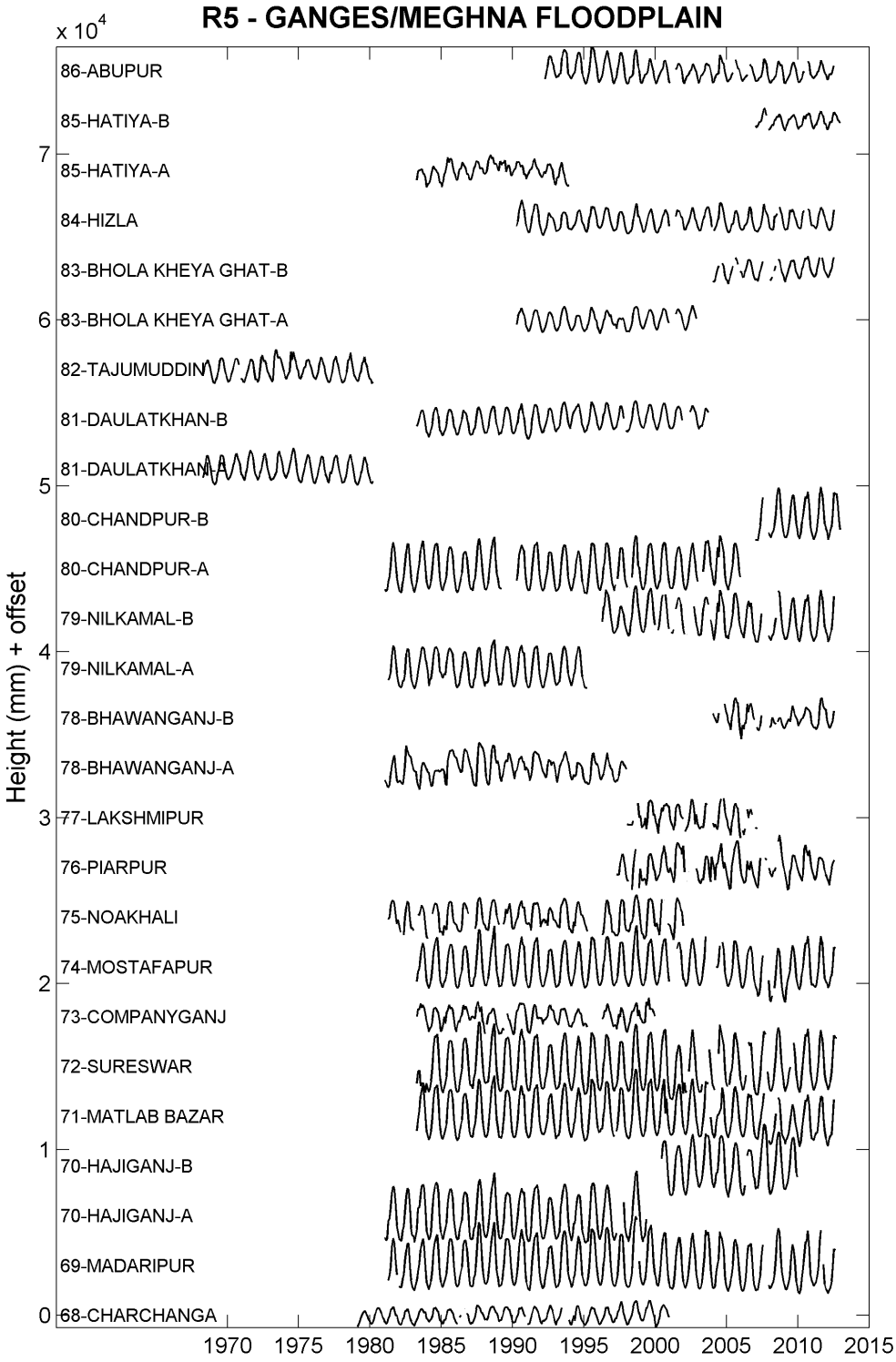

Fig. S1e. Water level gauges time series from the Region 5 - Ganges/Meghna rivers floodplain.

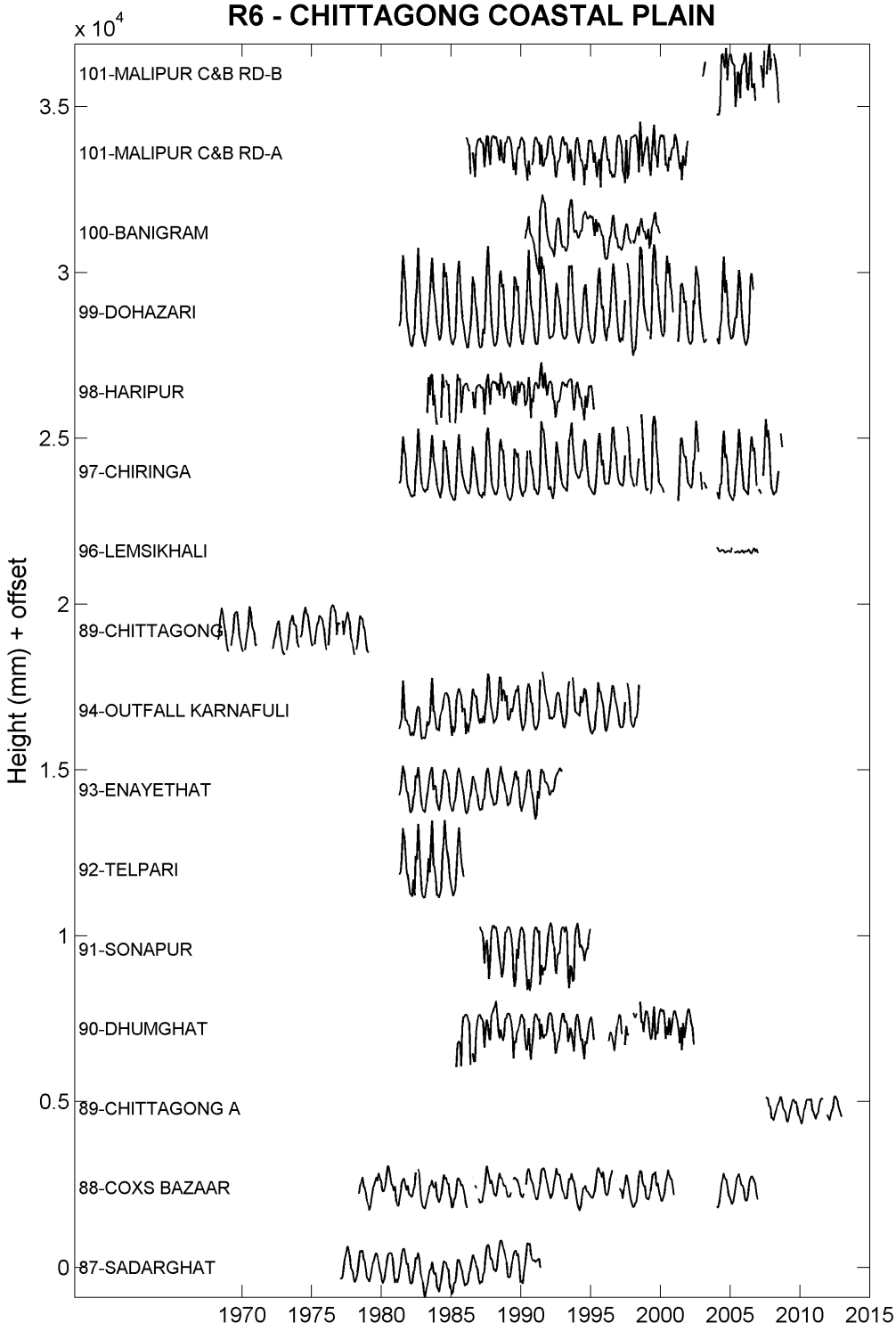

Fig. S1f. Water level gauges time series from the Region 6 - Chittagong coastal plain.

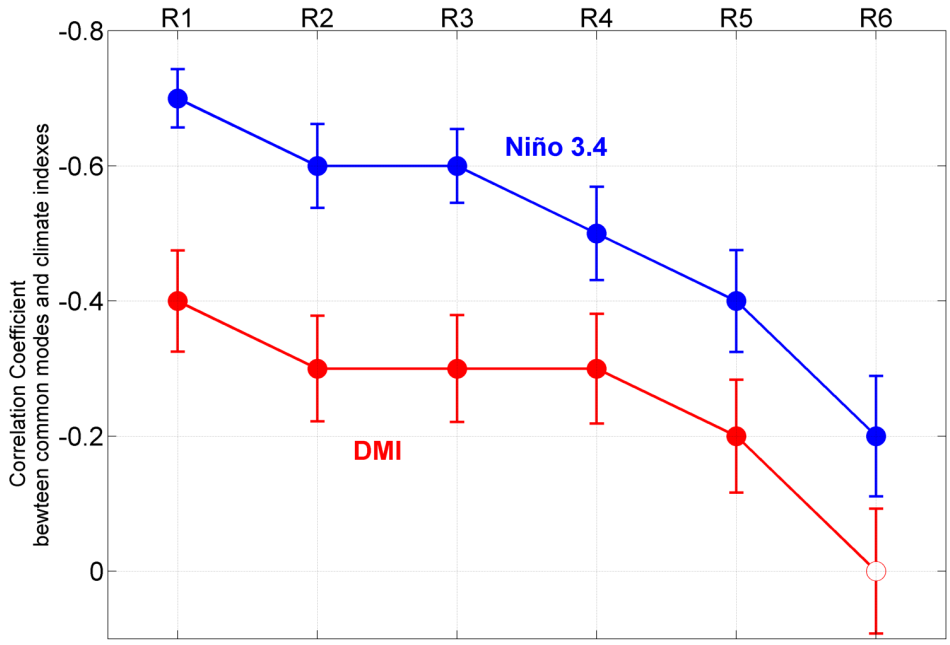

Fig. S2. Correlation coefficient between regional RWL time series and climate indexes. The correlation coefficients are estimated between the detrended regional RWL and Niño 3.4 index and DMI respectively and given whit their 95% confidence interval (two-tail). All the coefficients are significantly different from zero ($p<0.001$), excepted with DMI in R6 ($p>0.4$, white point).

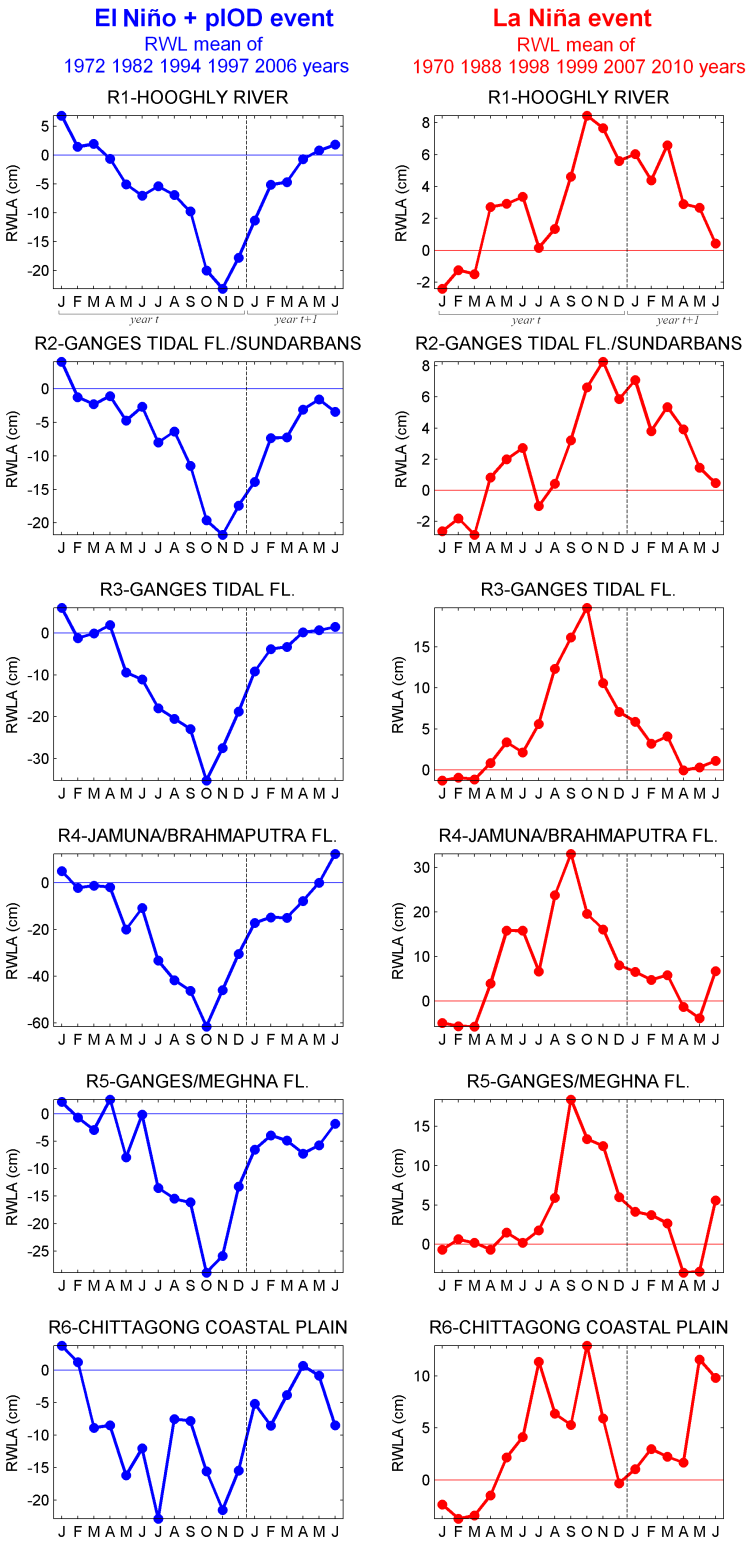

Fig. S3. Evolution of the average interannual RWL anomaly (RWLA) for each region : On the left side , in blue, the RWLA average during El Niño + pIOD events (1972, 1982, 1994, 1997 and 2006, in blue) and on the right side ,in red, the RWLA average during La Niña events (1970, 1988, 1998, 1999, 2007 and 2010).

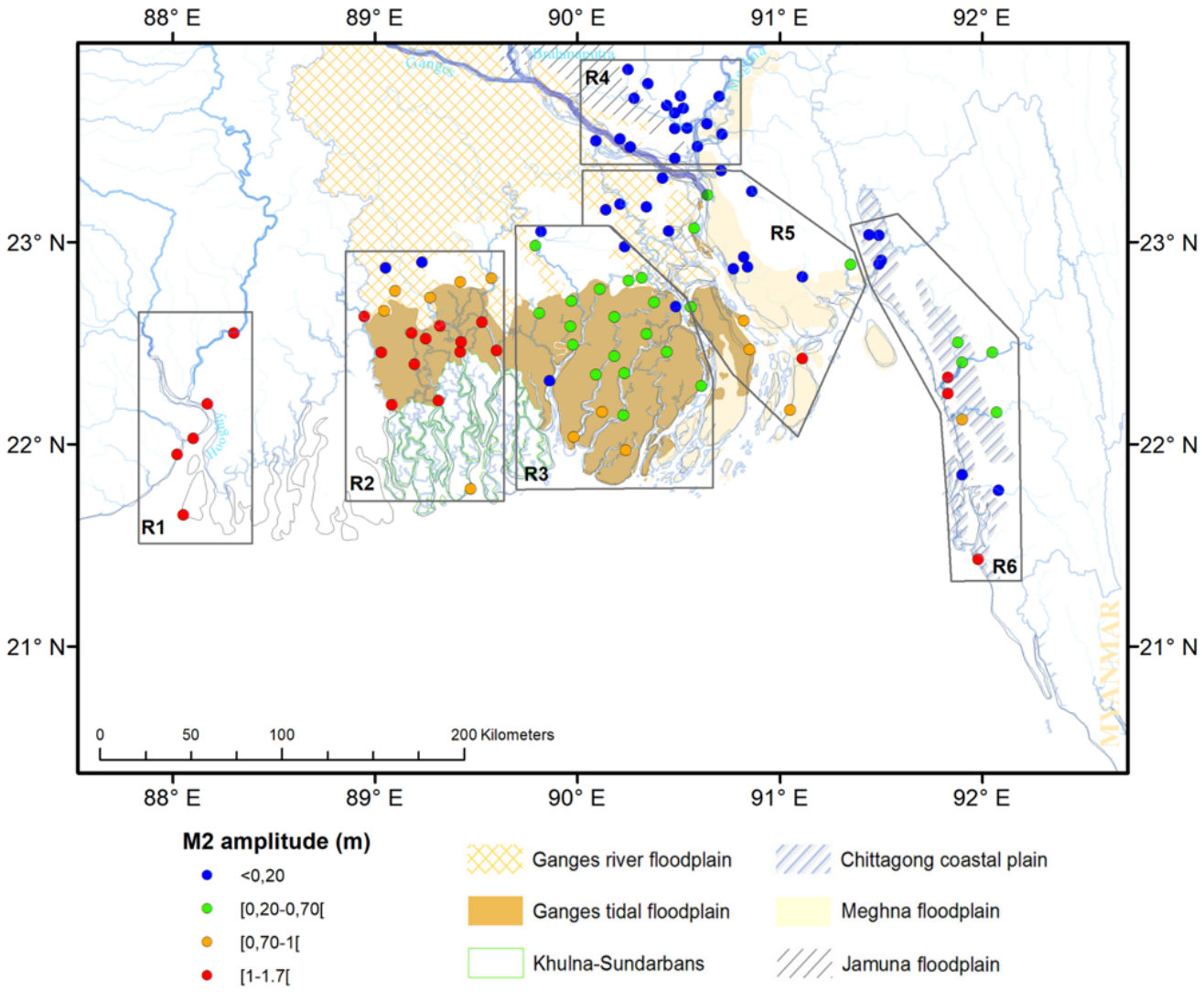

Fig. S4. Regionalization parameters: M_2 tidal constituent amplitude (in meters) from the water level records of the Bangladesh Water Development Board (1), the physiogeographic units originate from (2) and the river network derived from HydroSHEDS (https://www.hydrosheds.org/).

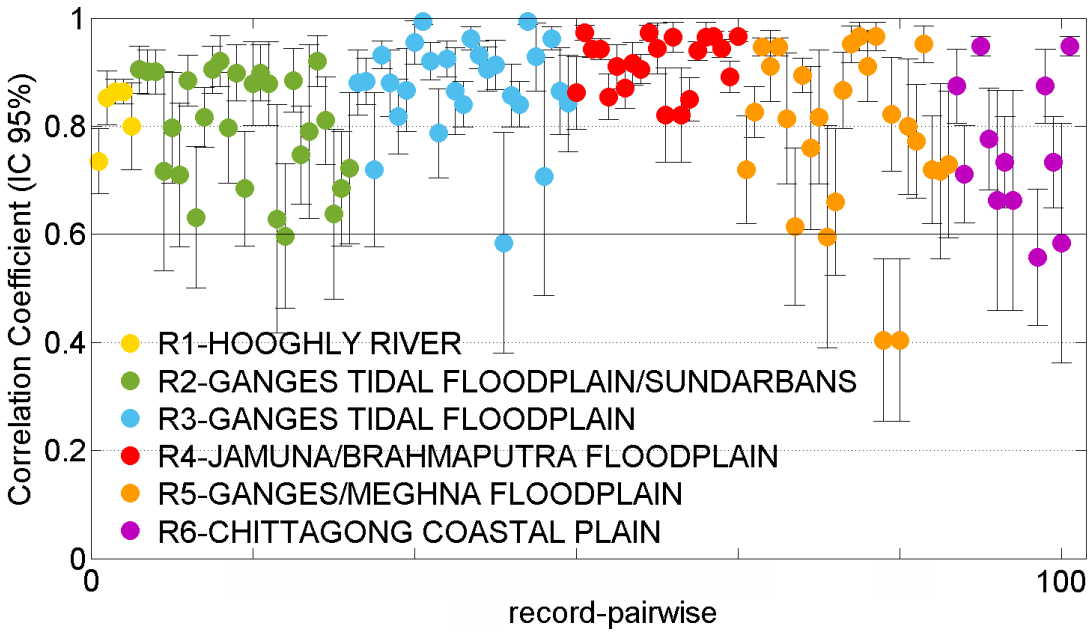

Fig. S5. Station-pairwise maximum correlation coefficients. The correlation coefficient is calculated for the 12yr-running mean detrended relative sea-level (RWL). At each site by regions, it presents the maximum of correlation coefficient between the monthly RWL for each site and the monthly RWL for all the other sites into the region. This coefficient computed only if the records overlapped for at least 2 years. The error bars correspond to a 95% confidence interval. The correlation coefficients are generally greater than 0.6, except for the Tajumuddin and Daulatkhan sites (r is in [0.3 0.6] estimated for 10 years) in R5. Although their correlation coefficient is low, these records are used to perform the comparison with model predicted RWL rates, because these measurements are the only information available for the 1968-1980 period in this region.

Table S1. Summary table of the water level gauges network. 'ID' corresponds to the station location on Figure 1, 'Code' is the institution ID ('SW' from BUET and 'P' from PSMSL).

ID	Code	NAME	Lat	Lon	Date		Length(yr)	% Missing (max consecutive months missing)
REGION 1 – HOOGHLY RIVER (5)								
1	P0369	GARDIEN REACH	22,6	88,3	1976	1996	21	2%(1)
2	P0417	SAUGOR	21,7	88,1	1968	1982	15	1%(1)
3	P0543	DIAMOND HARBOUR	22,2	88,2	1968	2012	45	4%(22)
4	P1270	HALDIA	22,0	88,1	1970	2012	43	5%(22)
5	P1369	GANGRA	22,0	88,0	1974	2006	33	3%(2)
REGION 2 – GANGES TIDAL FLOODPLAIN/SUNDARBANS								
6	P1451	HIRON POINT	21,8	89,5	1977	2003	27	1%(1)
7	SW023	KALAROA	22,9	89,0	1968	1978	10	3%(2)
8	SW024	BENARPOTA	22,8	89,1	1968	2003	35	5%(12)
9	SW025	CHAPRA	22,5	89,2	1983	2000	18	0%(0)
10	SW026A	PROTAPNAGAR	22,4	89,2	1968	1980	13	5%(8)
10	SW026B	PROTAPNAGAR	22,4	89,2	1983	2003	21	1%(2)
11	SW027	KESHABPUR	22,9	89,2	1968	1985	18	1%(1)
12	SW028	DUMURIA	22,8	89,4	1982	1993	11	0%(0)
13	SW029	SUTARKHALI FOREST OFFICE	22,5	89,4	1981	1997	17	1%(2)
14	SW128A	SHAKRA	22,6	88,9	1983	1992	9	3%(3)
14	SW128B	SHAKRA	22,6	88,9	1993	1999	7	0%(0)
15	SW129A	BASANTAPUR	22,5	89,0	1968	1975	8	0%(0)
15	SW129B	BASANTAPUR	22,5	89,0	1983	2012	29	2%(4)
16	SW130A	KAIKHALI	22,2	89,1	1984	1994	10	0%(0)
16	SW130B	KAIKHALI	22,2	89,1	1996	2012	16	7%(4)
17	SW163A	TALA MAGURA	22,7	89,3	1983	1989	7	0%(0)
17	SW163B	TALA MAGURA	22,7	89,3	1993	2001	8	0%(0)
18	SW164	CHANDKHALI	22,5	89,3	1981	2001	20	1%(1)
19	SW165	KOBADAK FOREST OFFICE	22,2	89,3	1981	1993	13	1%(2)
20	SW241	KHULNA	22,8	89,6	1981	2014	34	8%(12)
21	SW243A	CHALNA	22,6	89,5	1968	1978	10	0%(0)
21	SW243B	CHALNA	22,6	89,5	1980	1992	12	8%(12)
22	SW244A	MONGLA	22,5	89,6	1983	2000	17	8%(12)
22	SW244B	MONGLA	22,5	89,6	2002	2012	10	1%(1)
23	SW254.5	ELARCHAR	22,7	89,0	1983	1992	9	0%(0)
24	SW258	PAIKGACHA	22,6	89,3	1983	1997	15	0%(0)
25	SW259	NALIANALA	22,5	89,4	1968	1980	13	16%(12)
REGION 3 – GANGES TIDAL FLOODPLAIN								
26	P1454	KHEPUPARA	22,0	90,2	1978	2000	23	5%(4)
27	SW001	BAGERHAT	22,6	89,8	1983	2000	18	0%(0)
28	SW018.1	BAKERGANJ	22,5	90,3	1981	2005	24	0%(0)
29	SW018	BARISAL	22,7	90,4	1981	2012	32	2%(4)
30	SW019	MIRZAGANJ	22,4	90,2	1990	2010	20	0%(0)
31	SW020	AMTALI	22,1	90,2	1984	2000	17	2%(4)
32	SW037.5	BETAGI	22,4	90,2	1993	1998	6	0%(0)
33	SW037A	JHALOKATI	22,6	90,2	1981	1995	14	0%(0)
33	SW037B	JHALOKATI	22,6	90,2	1996	2005	10	5%(4)
34	SW038.1	BARGUNA	22,2	90,1	1990	2012	22	8%(10)
35	SW038	BAMNA	22,3	90,1	1982	2012	30	2%(4)
36	SW039A	PATHARGHATA	22,0	90,0	1981	1989	9	1%(1)
36	SW039B	PATHARGHATA	22,0	90,0	1990	2005	16	4%(8)
37	SW105	OFFTAKE AT ATHAROBANKA	23,0	89,8	1968	2006	39	8%(12)
38	SW107.2	RAYENDA	22,3	89,9	1984	1996	13	0%(0)
39	SW107A	NAZIRPUR	22,7	90,0	1991	2001	11	1%(1)
40	SW107	PIROJPUR	22,6	90,0	1981	2012	31	2%(4)
41	SW136.1A	UMEDPUR	22,5	90,0	1990	2003	13	3%(4)
41	SW136.1B	UMEDPUR	22,5	90,0	2004	2012	8	7%(4)
42	SW183	KAITPARA	22,5	90,4	1990	2003	13	19%(24)
43	SW198	HARIDASPUR	23,1	89,8	1968	1996	29	15%(12)
44	SW253A	UZIRPUR	22,8	90,3	1991	1999	9	0%(0)
45	SW253	SWARUPKATI	22,8	90,1	1981	1999	19	0%(0)
46	SW288.3	TONGIBARI	22,7	90,5	1991	1999	9	13%(12)
47	SW290	DASMUNIA	22,3	90,6	1990	2002	12	3%(2)
48	SW300	GOURNADI	23,0	90,2	1996	2003	7	5%(4)
49	SW318	BABUGANJ	22,8	90,3	1991	2003	12	3%(4)

REGION 4 – JAMUNA/BRAHMAPUTRA FLOODPLAIN								
50	SW004A	OFFTAKE OF ARIALKHAN	23,5	90,1	1968	1990	23	11%(17)
50	SW004B	OFFTAKE OF ARIALKHAN	23,5	90,1	1996	2005	9	9%(5)
51	SW007.5	DEMRA	23,7	90,5	1968	2009	42	5%(12)
52	SW042	DHAKA	23,7	90,4	1987	2008	22	1%(1)
53	SW043	HARIHARPARA	23,6	90,5	1983	1999	17	4%(4)
54	SW069A	SAVAR	23,8	90,2	1968	1978	11	6%(6)
55	SW070	KALATIA	23,7	90,3	1983	1999	17	1%(1)
56	SW071A	REKABI BAZAR	23,6	90,5	1983	2008	26	6%(12)
57	SW071	KALAGACHIA	23,6	90,5	1983	2008	26	3%(3)
58	SW093.4L	BHAGYAKUL	23,5	90,2	1983	2003	20	1%(1)
59	SW093.5LA	MAWA	23,5	90,3	1983	2003	20	2%(1)
59	SW093.5LB	MAWA	23,5	90,3	2004	2012	9	9%(4)
60	SW094A	TARPASA	23,4	90,5	1983	2003	20	1%(1)
60	SW094B	TARPASA	23,4	90,5	2004	2014	11	12%(12)
61	SW115	DAUDKANDI	23,5	90,7	1981	2008	28	4%(4)
62	SW179B	DEMRA	23,7	90,5	1968	2009	42	5%(12)
63	SW180B	NARAYANGANJ	23,7	90,5	1997	2009	13	7%(6)
64	SW275.5	MEGHNA	23,6	90,6	1981	2001	21	5%(12)
65	SW275B	BADYAR BAZAR	23,7	90,7	1987	2005	19	5%(10)
66	SW276	SATNAL	23,5	90,6	1981	2003	22	7%(12)
67	SW302	MIRPUR	23,8	90,3	1981	2008	28	3%(4)
REGION 5 – GANGES/MEGHNA RIVERS FLOODPLAIN								
68	P1496	CHARCHANGA	22,2	91,1	1979	2000	22	3%(4)
69	SW005	MADARIPUR	23,2	90,2	1981	2012	31	2%(4)
70	SW058A	HAJIGANJ	23,3	90,9	1981	1999	18	2%(5)
70	SW058B	HAJIGANJ	23,3	90,9	2000	2009	10	1%(1)
71	SW079	MATLAB BAZAR	23,4	90,7	1983	2012	29	1%(3)
72	SW095	SURESWAR	23,3	90,4	1983	2012	29	3%(5)
73	SW182	COMPANYGANJ	22,9	91,4	1983	1999	17	8%(12)
74	SW190	MOSTAFAPUR	23,2	90,1	1983	2012	29	5%(8)
75	SW222	NOAKHALI	22,8	91,1	1981	2001	21	12%(12)
76	SW239.5	PIARPUR	22,9	90,8	1997	2012	15	8%(5)
77	SW239	LAKSHMIPUR	22,9	90,8	1998	2007	9	7%(3)
78	SW240A	BHAWANGANJ	22,9	90,8	1981	1997	17	0%(0)
78	SW240B	BHAWANGANJ	22,9	90,8	2004	2012	9	7%(4)
79	SW277.3A	NILKAMAL	23,1	90,6	1981	1995	14	0%(0)
79	SW277.3B	NILKAMAL	23,1	90,6	1996	2012	16	7%(5)
80	SW277A	CHANDPUR	23,2	90,6	1981	2005	25	6%(12)
80	SW277B	CHANDPUR	23,2	90,6	2007	2014	7	5%(4)
81	SW278A	DAULATKHAN	22,6	90,8	1968	1980	12	0%(0)
81	SW278B	DAULATKHAN	22,6	90,8	1983	2003	20	3%(6)
82	SW279	TAJUMUDDIN	22,5	90,9	1968	1980	12	0%(0)
83	SW288.4A	BHOLA KHEYA GHAT	22,7	90,6	1990	2002	13	3%(4)
83	SW288.4B	BHOLA KHEYA GHAT	22,7	90,6	2004	2012	9	8%(4)
84	SW320	HIZLA	23,1	90,4	1990	2012	22	2%(4)
85	SW321A	HATIYA	22,4	91,1	1983	1993	11	0%(0)
85	SW321B	HATIYA	22,4	91,1	2007	2014	7	0%(0)
86	SW323	ABUPUR	23,2	90,3	1992	2012	20	2%(4)
REGION 6 – CHITTAGONG COASTAL PLAIN								
87	P0416	SADARGHAT	22,3	91,8	1977	1991	14	0%(0)
88	P1476	COXS BAZAAR	21,4	92,0	1978	2006	29	12%(34)
89	P2196	CHITTAGONG A	22,3	91,8	2007	2012	6	5%(3)
90	SW086	DHUMGHAT	22,9	91,5	1985	2002	17	8%(12)
91	SW087	SONAPUR	22,9	91,5	1987	1994	8	0%(0)
92	SW120A	TELPARI	22,5	91,9	1981	1985	5	0%(0)
93	SW121	ENAYETHAT	22,4	91,9	1981	1992	12	0%(0)
94	SW125	OUTFALL KARNAFULI	22,5	92,1	1981	1998	17	0%(1)
95	SW153	CHITTAGONG	22,3	91,8	1968	1979	11	15%(10)
96	SW176	LEMSIKHALI	21,8	91,9	2004	2006	3	0%(0)
97	SW204	CHIRINGA	21,8	92,1	1981	2008	27	7%(12)
98	SW213	HARIPUR	23,0	91,5	1983	1995	12	3%(2)
99	SW248	DOHAZARI	22,2	92,1	1981	2006	26	4%(7)
100	SW250	BANIGRAM	22,1	91,9	1990	1999	10	0%(0)
101	SW257A	MALIPUR C&B RD	23,0	91,4	1986	2001	16	1%(1)
101	SW257B	MALIPUR C&B RD	23,0	91,4	2003	2008	6	17%(8)

Table S2. Regional RWL time series cross-correlation. The correlation coefficients are estimated between the detrended regional RWL common modes. All the coefficients are significantly different from zero ($p<0.001$).

	R1-HOOGHLY RIVER	R2-GANGES TIDAL FLOODPLAIN/SUNDARBANS	R3-GANGES TIDAL FLOODPLAIN	R4-JAMUNA/BRAHMAPUTRA FLOODPLAIN	R5-GANGES/MEGHNA FLOODPLAIN	R6-CHITTAGONG COASTAL PLAIN
R1-HOOGHLY RIVER		0.7	0.5	0.5	0.4	0.3
R2-GANGES TIDAL FLOODPLAIN/SUNDARBANS	0.7		0.5	0.4	0.4	0.3
R3-GANGES TIDAL FLOODPLAIN	0.6	0.5		0.6	0.4	0.2
R4-JAMUNA/BRAHMAPUTRA FLOODPLAIN	0.5	0.4	0.6		0.8	0.4
R5-GANGES/MEGHNA FLOODPLAIN	0.4	0.4	0.4	0.8		0.4
R6-CHITTAGONG COASTAL PLAIN	0.3	0.3	0.2	0.4	0.4	

Table S3a. Contributions of sea-level rise for 2050 with respect to 1986/2005 in the Bay of Bengal (unit: m), based on the Integrated Climate Data Center (ICDC) at the University of Hamburg (http://icdc.cen.uni-hamburg.de/1.html) (notation: median [likely range]).

	RCP 4.5	RCP 8.5
Total (ICDC)	0.22 [0.14; 0.30]	0.24 [0.17; 0.32]

Table S3b. Contributions of sea-level rise for 2100 with respect to 1986/2005 in the Bay of Bengal (unit: m), based on the ICDC (http://icdc.cen.uni-hamburg.de/1.html) and Golledge et al. (3) for Antarctica (notation: median [likely range]). The upper projections of Golledge et al. (3), which include MISI, is 4 cm higher than the IPCC Antarctica contribution (16 cm). Because some components are uncorrelated, the sum of the upper bounds of the likely ranges of all components is larger than the upper bound of the likely range of the total (4). Note that the regional ICDC and global IPCC projections are not exactly the same due to different methods used on global and regional scales (4).

	RCP 4.5	RCP 8.5
Sterodynamic component	0.23 [0.16; 0.30]	0.35 [0.27; 0.43]
Mountain Glaciers	0.13 [0.07; 0.19]	0.17 [0.10; 0.25]
Greenland	0.10 [0.06; 0.18]	0.17 [0.10 to 0.31]
Antarctica (IPCC)	0.06 [–0.06; 0.17]	0.05 [–0.07 to 0.16]
Groundwater	0.01 [0; 0.02]	0.01 [0; 0.02]
Global Isostatic Adjustment	0 [-0.02; 0.02]	0 [-0.02; 0.02]
Total (ICDC)	0.53 [0.34; 0.74]	0.74 [0.50; 1.03]
Antarctica from Golledge et al. (3)*	0.06	0.20

* Golledge et al. (3) project the Antarctic contribution to sea-level rise to reach 0.18m in 2100 globally, which implies 0.2m in the Bay of Bengal due to the changes in Earth Gravity, Earth Rotation and solid Earth Deformation (5–7).

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