

## Overview

The coastal areas around the world are likely to be among the most affected by climate change and its impacts due to a complex interplay among atmospheric, marine and terrestrial processes, as well to local exposure of coastal areas in terms in infrastructure and occupation.

It is important to understand that communities in different urban areas in coastal regions and from different socio-economic activities face different levels of risk and vulnerability.

The METROPOLE project (funded by the BELMONT Forum) represents a partnership between Brazil, UK and US to investigate impacts of sea level rise and climate change in some three coastal regions around the world (Brazil: Santos-SP, the United Kingdom: Selsey-West Sussex, and the United States: Broward County-Florida). The hypothesis of the project is that risk knowledge is best understood as being co-produced by science and by the social, political and cultural context. The project intends to use:

- The state of the art in visualization tools developed by Brazil and the United States;
- Surveys, sophisticated questionnaires and tools for evaluation of options for adaptation;
- Risk studies using the Index of Adaptive Capacity developed in the UK and to be replicated in Brazil.

The expected results include the generation of a new evaluation system for quantifying the influence of the integration of scientific, economic and cultural data in adaptive planning and decision-making. This system aims at improving the ease of interaction between scientists and decision-makers.

The central theme of the METROPOLE project is, therefore, to show, in an integrated way, how some coastal areas under different climate regimes and human pressures would be affected by SLR caused by climate change, and if society and the government would be prepared or not to take proper and fast adaptation measures.

**Keywords:** Sea level rise, climate change, climate extremes, coastal regions, adaptation

## What is COAST?

- The COastal Adaptation to Sea level rise Tool (COAST) is software that models flooding damage to assets from storm surge and sea level rise over time
- It can calculate one-time damages from a single event in time; as well as cumulative damage from all possible storms over a given time period
- It then is used to calculate the benefits and costs from various adaptation strategies to determine which strategy is the most fiscally efficient over time

- COAST uses digital parcels maps to identify the elevation of individual parcels in a given study area
- Parcels maps contain market values for both buildings and land



Final report about high waters in Santos  
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1 - INTRODUCTION  
One set of sea level data was analyzed:

1) Tide gauge data in Torre Grande (1945-1990).  
The tide gauge is located in Channel of the Port of Santos. Computations were performed for sea level (astronomical surge) and mean sea level (only meteorological effects).

2) Sea level extremes:  
2) Mean sea level extremes.  
3) Sea level extremes trends.  
4) Mean sea level extremes trends.  
5) Extreme sea levels for return periods of 10, 50 and 100 years.  
6) Extreme mean sea levels for return periods of 10, 50 and 100 years.  
7) High water mean, median, standard deviation and maximum values.

Sea level extremes were detected by processing sea level to Minimum values at times t were given by satisfying the condition: Level (time t-1) < level (time t) < level (time t+1)  
And level (time t) < mean sea level

Maximum values at times t were given by satisfying the condition: Level (time t-1) > level (time t) > level (time t+1)  
And level (time t) > mean sea level

III – FINAL REMARKS  
The astronomical tide in Santos produces these mean levels:

Mean level of maximum spring tides (m)	Levels relative to mean sea level (m)
0.23	0.23
0.31	0.31
0.34	0.34
0.37	0.37
0.41	0.41
0.45	0.45
0.51	0.51
0.57	0.57
0.63	0.63
0.70	0.70
0.78	0.78
0.89	0.89
1.00	1.00
1.14	1.14
1.30	1.30
1.48	1.48
1.69	1.69
1.94	1.94
2.23	2.23
2.56	2.56
2.93	2.93
3.34	3.34
3.79	3.79
4.28	4.28
4.81	4.81
5.38	5.38
5.99	5.99
6.64	6.64
7.33	7.33
8.06	8.06
8.83	8.83
9.64	9.64
10.49	10.49
11.38	11.38
12.31	12.31
13.28	13.28
14.29	14.29
15.34	15.34
16.43	16.43
17.56	17.56
18.73	18.73
19.94	19.94
21.19	21.19
22.48	22.48
23.81	23.81
25.18	25.18
26.59	26.59
28.04	28.04
29.53	29.53
31.06	31.06
32.63	32.63
34.24	34.24
35.89	35.89
37.58	37.58
39.31	39.31
41.08	41.08
42.89	42.89
44.74	44.74
46.63	46.63
48.56	48.56
50.53	50.53
52.54	52.54
54.59	54.59
56.68	56.68
58.81	58.81
60.98	60.98
63.19	63.19
65.44	65.44
67.73	67.73
70.06	70.06
72.43	72.43
74.84	74.84
77.29	77.29
79.78	79.78
82.31	82.31
84.88	84.88
87.49	87.49
90.14	90.14
92.83	92.83
95.56	95.56
98.33	98.33
101.14	101.14
104.00	104.00
106.90	106.90
109.84	109.84
112.82	112.82
115.84	115.84
118.90	118.90
122.00	122.00
125.14	125.14
128.32	128.32
131.54	131.54
134.80	134.80
138.10	138.10
141.44	141.44
144.82	144.82
148.24	148.24
151.70	151.70
155.20	155.20
158.74	158.74
162.32	162.32
165.94	165.94
169.60	169.60
173.30	173.30
177.04	177.04
180.82	180.82
184.64	184.64
188.50	188.50
192.40	192.40
196.34	196.34
200.32	200.32
204.34	204.34
208.40	208.40
212.50	212.50
216.64	216.64
220.82	220.82
225.04	225.04
229.30	229.30
233.60	233.60
237.94	237.94
242.32	242.32
246.74	246.74
251.20	251.20
255.70	255.70
260.24	260.24
264.82	264.82
269.44	269.44
274.10	274.10
278.80	278.80
283.54	283.54
288.32	288.32
293.14	293.14
298.00	298.00
302.90	302.90
307.84	307.84
312.82	312.82
317.84	317.84
322.90	322.90
328.00	328.00
333.14	333.14
338.32	338.32
343.54	343.54
348.80	348.80
354.10	354.10
359.44	359.44
364.82	364.82
370.24	370.24
375.70	375.70
381.20	381.20
386.74	386.74
392.32	392.32
397.94	397.94
403.60	403.60
409.30	409.30
415.04	415.04
420.82	420.82
426.64	426.64
432.50	432.50
438.40	438.40
444.34	444.34
450.32	450.32
456.34	456.34
462.40	462.40
468.50	468.50
474.64	474.64
480.82	480.82
487.04	487.04
493.30	493.30
499.60	499.60
505.94	505.94
512.32	512.32
518.74	518.74
525.20	525.20
531.70	531.70
538.24	538.24
544.82	544.82
551.44	551.44
558.10	558.10
564.80	564.80
571.54	571.54
578.32	578.32
585.14	585.14
592.00	592.00
598.90	598.90
605.84	605.84
612.82	612.82
619.84	619.84
626.90	626.90
634.00	634.00
641.14	641.14
648.32	648.32
655.54	655.54
662.80	662.80
670.10	670.10
677.44	677.44
684.82	684.82
692.24	692.24
699.70	699.70
707.20	707.20
714.74	714.74
722.32	722.32
729.94	729.94
737.60	737.60
745.30	745.30
753.04	753.04
760.82	760.82
768.64	768.64
776.50	776.50
784.40	784.40
792.34	792.34
800.32	800.32
808.34	808.34
816.40	816.40
824.50	824.50
832.64	832.64
840.82	840.82
849.04	849.04
857.30	857.30
865.60	865.60
873.94	873.94
882.32	882.32
890.74	890.74
899.20	899.20
907.70	907.70
916.24	916.24
924.82	924.82
933.44	933.44
942.10	942.10
950.80	950.80
959.54	959.54
968.32	968.32
977.14	977.14
986.00	986.00
994.90	994.90
1003.84	1003.84
1012.82	1012.82
1021.84	1021.84
1030.90	1030.90
1040.00	1040.00
1049.14	1049.14
1058.32	1058.32
1067.54	1067.54
1076.80	1076.80
1086.10	1086.10
1095.44	1095.44
1104.82	1104.82
1114.24	1114.24
1123.70	1123.70
1133.20	1133.20
1142.74	1142.74
1152.32	1152.32
1161.94	1161.94
1171.60	1171.60
1181.30	1181.30
1191.04	1191.04
1200.82	1200.82
1210.64	1210.64
1220.50	1220.50
1230.40	1230.40
1240.34	1240.34
1250.32	1250.32
1260.34	1260.34
1270.40	1270.40
1280.50	1280.50
1290.64	1290.64
1300.82	1300.82
1311.04	1311.04
1321.30	1321.30
1331.60	1331.60
1341.94	1341.94
1352.32	1352.32
1362.74	1362.74
1373.20	1373.20
1383.70	1383.70
1394.24	1394.24
1404.82	1404.82
1415.44	1415.44
1426.10	1426.10
1436.80	1436.80
1447.54	1447.54
1458.32	1458.32
1469.14	1469.14
1480.00	1480.00
1490.90	1490.90
1501.84	1501.84
1512.82	1512.82
1523.84	1523.84
1534.90	1534.90
1546.00	1546.00
1557.14	1557.14
1568.32	1568.32
1579.54	1579.54
1590.80	1590.80
1602.10	1602.10
1613.44	1613.44
1624.82	1624.82
1636.24	1636.24
1647.70	1647.70
1659.20	1659.20
1670.74	1670.74
1682.32	1682.32
1693.94	1693.94
1705.60	1705.60
1717.30	1717.30
1729.04	1729.04
1740.82	1740.82
1752.64	1752.64
1764.50	1764.50
1776.40	1776.40
1788.34	1788.34
1800.32	1800.32
1812.34	1812.34
1824.40	1824.40
1836.50	1836.50
1848.64	1848.64
1860.82	1860.82
1873.04	1873.04
1885.30	1885.30
1897.60	1897.60
1910.00	1910.00
1922.44	1922.44
1934.90	1934.90
1947.40	1947.40
1959.94	1959.94
1972.50	1972.50
1985.10	1985.10
1997.74	1997.74
2010.40	2010.40
2023.10	2023.10
2035.84	2035.84
2048.60	2048.60
2061.40	2061.40
2074.24	2074.24
2087.10	2087.10
2100.00	2100.00

- COAST uses storm surge heights of varying storm strengths (i.e., 10-year, 50-year, 100-year, etc.) to model one-time damages and cumulative damages from a variety of storms over time