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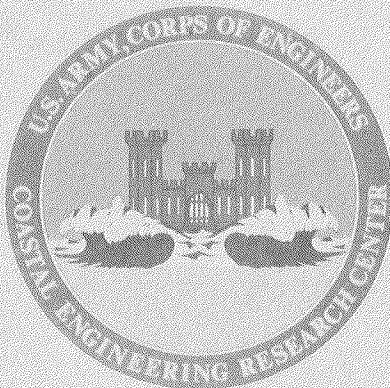
TP 77-13

## Development of Surge II Program With Application to the Sabine-Calcasieu Area for Hurricane Carla and Design Hurricanes

by

Robert O. Reid, Andrew C. Vastano, and Thomas J. Reid

TECHNICAL PAPER NO. 77-13  
NOVEMBER 1977



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Prepared for

U.S. ARMY, CORPS OF ENGINEERS

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Design hurricane	Inland flooding model							
Hurricane Carla	Sabine-Calcasieu region							
Hurricane surge model	Surge II program							
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) SURGE II is a program for calculation of storm surges and tides in a bay or estuary of the type where frictional resistance dominates over Coriolis force. It includes the provision for subgrid scale barriers and channels as well as allowing for overtopping of barriers and flooding of and recession from normally dry regions adjoining the bay or estuary. The theory and numerical algorithm is discussed in detail. A user's guide for the program is also provided. Application of the program, in respect to astronomical tides and (continued)								

hurricane surges, is made for the Sabine-Calcasieu region which straddles the Texas and Louisiana boundary. For normal tide conditions, cities such as Beaumont, Orange, and Lake Charles are connected to the sea via rivers, which in the numerical model must be represented as subgrid scale channels as long as the basic grid scale is of the order of a nautical mile. Under hurricane surge conditions, however, the overland flooding can greatly expand their connection to the sea.

Calibration of channel friction is carried out via the astronomical tide simulation. Calibration of the block friction is carried out using data on a previous storm of record, Hurricane Carla. An example application is provided for standard project hurricanes (SPH). The response for a large radius SPH of slow speed and one of moderate speed of translation is examined. Also, the effect of rainfall is examined by running the latter storm with and without rainfall.

## PREFACE

This report is published to assist coastal engineers in the study of storm surge and inland flooding for use in the planning and design of protective coastal works. The work was carried out under the coastal processes program of the U.S. Army Coastal Engineering Research Center (CERC).

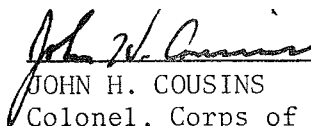
The report was prepared by Robert O. Reid, Andrew C. Vastano, and Thomas J. Reid, Coastal Studies, Inc., who are also on the staff of the Department of Oceanography, Texas A & M University, College Station, Texas, under CERC Contract No. DACW64-74-C-0015 to the U.S. Army Engineer District, Galveston.

The authors acknowledge the help of many individuals of the Galveston District, in providing most of the data necessary in schematizing the Sabine-Calcasieu system, the data for tidal calibration, the wind fields and observed water level data for Hurricane Carla, and the necessary input data for the Standard Project Hurricanes. G. Marinos and M. Choate assisted with various stages of the development and carried out the runs for the Standard Project Hurricane via the GE series 400 computer.

G. Marinos was the Galveston District contract monitor for the report under the general supervision of S. Tanner, Chief, Coastal Planning Section. Dr. Jon Hubertz was the CERC technical monitor of the report under the general supervision of Dr. D.L. Harris, Chief, Coastal Oceanography Branch, Research Division.

Comments on this publication are invited.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

  
\_\_\_\_\_  
JOHN H. COUSINS  
Colonel, Corps of Engineers  
Commander and Director

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55	J=JGAGE(K) IF (I.GT.KCM) GO TO 199 HS(K,N)=HC(I) 199 IF(J.NE.0) HS(K,N)=H(I,J) 200 CONTINUE	SAVE0046 SAVE0047 SAVE0048 SAVE0049 SAVE0050
60	C DO 300 J=1,NFLOW K=KFLOW(J) KEY=KEN(1,K) IF(KEY.NE.0) GO TO 205 KEY=2	SAVE0051 SAVE0052 SAVE0053 SAVE0054 SAVE0055
65	IF(IXCX(K).NE.0) KEY=1 205 GO TO(210,220,230,240,210,220,230,240), KEY 210 QS(J,N)=QCXN(K)/1000. GO TO 300	SAVE0056 SAVE0057 SAVE0058 SAVE0059
70	220 QS(J,N)=QCYN(K)/1000. GO TO 300 230 QS(J,N)=QCXP(K)/1000. GO TO 300	SAVE0060 SAVE0061 SAVE0062 SAVE0063
75	240 QS(J,N)=QCYP(K)/1000. 300 CONTINUE NU=72 IF(NE.0,72) GO TO 310 RETURN	SAVE0064 SAVE0065 SAVE0066 SAVE0067 SAVE0068
80	C 3000 NU = (NY=INTIME)/INTER IF(NU.EQ.0) RETURN 310 PRINT 400 400 FORMAT(20X, (WATER LEVEL HYDROGRAPHS (FT) AND KEY FLOWS (1000 CFS) (	SAVE0069 SAVE0070 SAVE0071 SAVE0072
85	1 //) PRINT 410, (J,J=1,NGAGE), (K,K=1,NFLOW) 410 FORMAT(2X, (HOUR(16,1518) DO 500 N=1,NU PRINT 420, TIME(N), (HS(J,N),J=1,NGAGE), (QS(K,N),K=1,NFLOW)	SAVE0073 SAVE0074 SAVE0075 SAVE0076 SAVE0077
90	420 FORMAT(F6.1,15F8.2) 425 FORMAT(F6.1,12F8.2) 500 CONTINUE DO 510 N=1,NU	SAVE0078 SAVE0080 SAVE0081 SAVE0082
95	430 FORMAT(F6.1,10F8.2) 510 CONTINUE PRINT 10 10 FORMAT(1H1) IF(NU.EQ.72) INTIME=NTIME RETURN	SAVE0084 SAVE0085 SAVE0086 SAVE0087 SAVE0088 SAVE0089
100	C END	SAVE0090
1	C C SUBROUTINE CONTN(L)	CONT0001
5	C COMMON/BLK1/A(822)/BLK2/B(1961)/BLK3/C(42)/BLK4/D(2585)/ 1BLK5/E(2759)/BLK6/F(2800)/BLK7/G(44)/BLK9/H(25)/BLK10/P(34)	CONT0002 CONT0003
10	C GO TO (100,200),L 100 CONTINUE 700 FORMAT(20A4) RETURN	CONT0004 CONT0006 CONT0007
15	C 200 CONTINUE RETURN C END	CONT0009 CONT0010

































































IDNT*	6	BLOCK	TOPOGRAPHY*	Z	VALUES	IN	FEET								
1	-24	-8	1	1	2	3	3	8	7	16					
1	11	19	23	26	32	35	30	20	35	100					
2	-24	-10	0	1	2	2	3	8	8	11					
2	7	14	15	23	25	35	30	20	35	100					
3	-24	-13	1	1	1	1	1	2	6	9					
3	4	7	11	16	22	25	30	7	7	100					
4	-24	-12	1	1	1	0	1	1	1	4					
4	12	13	14	20	23	15	3	7	7	100					
5	-24	-10	-1	0	1	-1	-1	-1	5	8					
5	15	17	15	1	1	1	7	7	7	100					
6	-16	-7	1	1	0	1	2	3	3	3					
6	15	7	1	1	7	1	10	20	25	100					
7	-8	1	1	1	-5	-5	-4	5	-1	5					
7	13	1	3	18	18	15	20	25	25	100					
8	-4	1	2	0	1	-5	-6	2	5	12					
8	12	1	6	15	18	20	25	25	30	100					
9	-15	2	2	1	1	-8	-7	-6	2	7					
9	1	1	13	15	17	15	25	27	30	100					
10	-20	-8	1	1	1	-5	-8	-8	-6	-4					
10	1	7	11	12	18	21	22	28	30	100					
11	-22	-10	1	3	1	1	-6	-7	-7	-6					
11	1	7	8	11	18	20	22	30	35	100					
12	-22	-13	3	2	1	1	1	1	-4	-3					
12	4	6	12	12	16	20	22	25	30	100					
13	-23	-15	5	2	1	1	1	1	1	1					
13	1	6	10	12	13	18	22	30	32	100					
14	-23	-13	4	1	1	1	1	1	1	1					
14	1	1	3	7	13	18	20	25	20	100					
15	-23	-12	2	1	1	1	0	0	1	1					
15	2	2	1	2	3	7	7	10	12	100					
16	-23	-12	1	1	1	1	0	0	1	1					
16	1	1	3	8	8	10	10	15	15	100					
17	-23	-12	1	1	1	0	0	0	1	3					
17	1	1	1	9	16	20	15	25	30	100					
18	-22	-11	1	1	1	0	0	1	3	3					
18	2	2	4	10	15	18	20	25	30	100					
19	-10	-8	-1	1	1	1	1	1	1	4					
19	5	8	8	11	14	18	20	20	32	100					
20	-17	1	1	1	1	1	1	1	1	1					
20	3	8	10	14	10	18	20	22	25	100					
21	-15	1	1	1	-4	1	0	7	-1	1					
21	3	6	10	12	14	18	20	22	25	100					
22	-15	1	1	-3	-4	1	1	5	0	1					
22	5	6	10	12	14	14	20	22	25	100					
23	-8	1	1	-4	-5	1	1	5	1	1					
23	4	6	12	13	14	14	20	22	25	100					
24	-10	1	1	-6	-7	-7	-7	-6	-6	1					
24	3	1	10	12	15	15	20	22	25	100					
25	-10	1	1	-5	-6	-5	-2	-6	1	1					
25	5	8	8	12	15	15	20	22	25	100					
26	-10	1	1	1	1	1	1	1	1	1					
26	4	8	1	-5	15	15	20	22	25	100					
27	-10	1	1	1	1	1	1	1	1	1					
27	4	8	8	1	12	15	20	22	25	100					
28	-10	100	100	100	100	100	100	100	100	100					
28	100	100	100	100	100	100	100	100	100	100					























































CHANNEL REACH 3

37	10	10	0.000	0.	0.	.396	2106.	1266.	.390	0.	0.	-823.	0.
38	11	10	0.000	0.	0.	.390	1266.	348.	.416	0.	0.	-866.	0.
39	12	10	0.000	0.	0.	.416	348.	-924.	.467	0.	0.	-1211.	0.
40	12	11	.467	-924.	-1013.	.505	-355.	-443.	.494	0.	0.	0.	0.
41	13	11	0.000	0.	0.	.494	-1456.	-1542.	.511	0.	0.	0.	0.
42	14	11	0.000	0.	0.	.511	-1542.	-1627.	.527	0.	0.	0.	0.
43	14	12	.527	-452.	-535.	.543	616.	535.	.535	0.	0.	0.	0.
44	13	12	.511	0.	0.	0.000	0.	0.	.543	0.	0.	0.	0.
45	13	13	.543	-616.	-695.	0.000	0.	0.	.549	0.	0.	0.	0.
46	14	13	.535	0.	0.	.549	-695.	-772.	.555	0.	0.	0.	0.
47	14	14	.555	-772.	-962.	0.000	0.	0.	.557	0.	0.	0.	0.
48	15	14	0.000	0.	0.	.557	-962.	-1094.	.560	0.	0.	0.	0.
49	15	15	.560	-1094.	-1224.	.568	1297.	1224.	.562	0.	0.	0.	0.
50	14	15	.557	0.	0.	0.000	0.	0.	.568	0.	0.	0.	0.
51	14	16	.568	-1297.	-1368.	0.000	0.	0.	.573	0.	0.	0.	0.
52	14	17	.573	-1368.	-1439.	0.000	0.	0.	.586	0.	0.	0.	0.
53	14	18	.586	-1439.	-1470.	0.000	0.	0.	.752	0.	0.	0.	0.
54	-14	19	.752	-1470.	-1500.	0.000	0.	0.	.917	0.	0.	0.	0.

CHANNEL REACH 4

55	11	11	.416	0.	0.	0.000	0.	0.	.505	0.	0.	0.	0.
56	11	12	.505	355.	266.	.522	-178.	-266.	.515	0.	0.	0.	0.
57	10	12	0.000	0.	0.	0.000	0.	0.	.522	0.	0.	0.	0.
58	10	13	.522	178.	89.	.531	-44.	-89.	.526	0.	0.	0.	0.
59	9	13	0.000	0.	0.	0.000	0.	0.	.531	0.	0.	0.	0.
60	-9	14	.531	44.	0.	0.000	0.	0.	.532	0.	0.	0.	0.

CHANNEL REACH 5

61	15	11	0.000	0.	0.	.527	-1175.	-1304.	.534	0.	0.	0.	0.
62	16	11	0.000	0.	0.	.534	-1304.	-1434.	.538	0.	0.	0.	0.
63	17	11	0.000	0.	0.	.538	-1434.	-1564.	.540	0.	0.	0.	0.
64	18	11	0.000	0.	0.	.540	-1564.	-1693.	.540	0.	0.	0.	0.
65	19	11	.532	1947.	1821.	.540	-1693.	-1821.	.537	0.	0.	0.	0.
66	19	10	0.000	0.	0.	0.000	0.	0.	.532	0.	0.	0.	0.
67	20	10	0.000	0.	0.	.532	-1947.	-2067.	.526	0.	0.	0.	0.
68	21	10	0.000	0.	0.	.526	-2067.	-2180.	.518	0.	0.	0.	0.
69	22	10	0.000	0.	0.	.518	-2180.	-2283.	.509	0.	0.	0.	0.
70	23	10	.484	5789.	5677.	.509	-2283.	-2373.	.500	0.	0.	0.	0.

CHANNEL REACH 6

71	-22	1	.590	50557.	54640.	0.000	0.	0.	.574	0.	0.	0.	0.
72	23	1	0.000	0.	0.	.574	12789.	12843.	.565	0.	0.	0.	0.
73	23	2	.565	12843.	12868.	.544	-12844.	-12868.	.555	0.	0.	0.	0.
74	22	2	.574	41852.	41875.	0.000	0.	0.	.544	0.	0.	0.	0.
75	22	3	.544	54759.	54752.	0.000	0.	0.	.495	0.	0.	0.	0.
76	22	4	.495	54752.	41901.	0.000	0.	0.	.371	0.	13290.	0.	0.
77	22	5	.371	41901.	25348.	0.000	0.	0.	.372	-11303.	5237.	0.	0.
78	23	5	0.000	0.	0.	.372	25348.	20711.	.393	0.	0.	-4574.	0.
79	23	6	.393	20711.	20625.	0.000	0.	0.	.415	0.	0.	0.	0.
80	23	7	.415	20625.	20533.	0.000	0.	0.	.438	0.	0.	0.	0.
81	23	8	.438	20533.	20434.	0.000	0.	0.	.461	0.	0.	0.	0.
82	23	9	.461	20434.	20327.	0.000	0.	0.	.484	0.	0.	0.	0.
83	24	9	0.000	0.	0.	.484	14539.	2173.	.495	0.	0.	-12163.	0.
84	24	10	.495	2173.	1949.	.500	3304.	3027.	.508	0.	0.	0.	0.
85	24	11	.508	4423.	4210.	0.000	0.	0.	.524	0.	0.	0.	0.
86	24	12	.524	4210.	3984.	0.000	0.	0.	.542	0.	0.	0.	0.
87	24	13	.542	3984.	3750.	0.000	0.	0.	.554	0.	0.	0.	0.
88	25	13	0.000	0.	0.	.554	3750.	3532.	.566	0.	0.	0.	0.
89	25	14	.566	3532.	2353.	0.000	0.	0.	.581	0.	1115.	0.	0.
90	26	14	0.000	0.	0.	.581	2353.	-389.	.589	0.	0.	-2599.	0.
91	27	14	0.000	0.	0.	.589	-389.	-528.	.591	0.	0.	0.	0.
92	27	15	.591	-528.	-665.	0.000	0.	0.	.592	0.	0.	0.	0.
93	-28	15	0.000	0.	0.	.592	-665.	-800.	.582	0.	0.	0.	0.

CHANNEL REACH 7

94	25	10	0.000	0.	0.	.508	553.	468.	.523	0.	0.	0.	0.
95	26	10	.547	-285.	-377.	.523	468.	377.	.536	0.	0.	0.	0.
96	26	9	0.000	0.	0.	0.000	0.	0.	.547	0.	0.	0.	0.
97	27	9	.561	-377.	-190.	.547	285.	190.	.556	0.	0.	0.	0.
98	27	8	0.000	0.	0.	0.000	0.	0.	.561	0.	0.	0.	0.
99	-28	8	0.000	0.	0.	.561	95.	0.	.563	0.	0.	0.	0.





















CHANNEL REACH 6

71	-22	1	7.000	317627.	335432.	3.200	0.	0.	6.002	-14111.	-32523.	0.	0.
72	23	1	3.200	0.	0.	6.002	114307.	99863.	5.334	0.	32077.	47784.	0.
73	23	2	5.135	99863.	45264.	5.135	9628.	-45264.	5.072	9256.	67210.	42334.	138703.
74	22	2	6.002	221125.	181204.	3.200	0.	0.	5.135	0.	41783.	0.	0.
75	22	3	5.135	171616.	136769.	3.200	0.	0.	4.768	0.	36195.	0.	0.
76	22	4	4.768	134769.	91854.	3.200	0.	0.	4.318	-27876.	19793.	0.	0.
77	22	5	4.318	91854.	62018.	3.200	0.	0.	4.265	-121662.	-92366.	0.	0.
78	23	5	3.200	0.	0.	4.265	62018.	53052.	4.214	0.	0.	91177.	100122.
79	23	6	4.214	53652.	46660.	3.200	0.	0.	4.205	-6737.	0.	0.	0.
80	23	7	4.205	46660.	41430.	3.200	0.	0.	4.201	-5363.	0.	0.	0.
81	23	8	4.201	41430.	41319.	3.200	0.	0.	4.199	0.	0.	0.	0.
82	23	9	4.199	41319.	31814.	3.200	0.	0.	4.192	-9464.	0.	0.	0.
83	24	9	3.200	0.	0.	4.192	26510.	18303.	4.149	0.	0.	-14730.	-6813.
84	24	10	4.149	18303.	11780.	4.206	12911.	9212.	4.164	-30137.	-27670.	21952.	27297.
85	24	11	4.164	11780.	6483.	3.200	0.	0.	4.163	447.	0.	0.	0.
86	24	12	4.163	6483.	13347.	3.200	0.	0.	4.206	7214.	0.	0.	0.
87	24	13	4.206	13347.	12907.	3.200	0.	0.	4.225	0.	0.	0.	0.
88	25	13	3.200	0.	0.	4.225	12907.	12064.	4.204	0.	0.	0.	0.
89	25	14	4.204	12064.	10608.	3.200	0.	0.	4.220	0.	1897.	0.	0.
90	26	14	3.200	0.	0.	4.220	10608.	6910.	4.196	0.	0.	-3524.	0.
91	27	14	3.200	0.	0.	4.196	6910.	-462.	4.168	0.	0.	-7162.	0.
92	27	15	4.168	-462.	-683.	3.200	0.	0.	4.164	0.	0.	0.	0.
93	-28	15	3.200	0.	0.	4.164	-683.	-900.	4.155	0.	0.	0.	0.

CHANNEL REACH 7

94	25	10	3.200	0.	0.	4.164	14666.	13275.	3.928	0.	0.	-1345.	0.
95	26	10	3.200	-9003.	-11328.	3.928	13275.	11328.	3.736	-11671.	-10231.	-1907.	0.
96	26	9	3.200	0.	0.	3.200	0.	0.	3.608	0.	0.	0.	0.
97	27	9	3.459	-200.	-5435.	3.608	9603.	5435.	3.562	-5108.	0.	13392.	17490.
98	27	8	3.200	0.	0.	3.200	0.	0.	3.459	0.	0.	0.	0.
99	-28	8	3.200	0.	0.	3.459	200.	0.	3.397	0.	0.	0.	0.

CHANNEL REACH 8

100	-1	4	3.200	0.	0.	7.663	0.	4713.	7.573	0.	0.	18851.	13965.
101	2	4	3.200	0.	0.	7.573	4713.	6561.	7.467	0.	0.	24550.	22509.
102	3	4	3.200	0.	0.	7.467	6561.	5027.	7.352	0.	0.	25098.	25045.
103	3	5	7.352	5027.	4621.	3.200	0.	0.	7.385	-25209.	-24380.	0.	0.
104	4	5	3.200	0.	0.	7.385	4621.	3341.	7.269	0.	0.	22011.	23746.
105	5	5	3.200	0.	0.	7.269	3341.	-208.	7.167	0.	0.	32412.	35883.
106	5	6	7.167	-248.	-3989.	3.200	0.	0.	7.167	-21252.	-17606.	0.	0.
107	5	7	7.167	0.	0.	3.200	0.	0.	7.090	0.	0.	0.	0.
108	5	8	7.090	-602.	-5247.	7.200	4607.	5247.	7.153	29979.	34510.	63646.	62858.
109	4	8	3.200	0.	0.	7.456	0.	0.	7.240	0.	0.	0.	0.
110	4	9	7.240	-4607.	-3041.	7.412	94.	3041.	7.305	-32403.	-34062.	8351.	5303.
111	3	9	7.456	3557.	6915.	3.200	0.	0.	7.412	-42020.	-45538.	0.	0.
112	3	8	3.200	0.	0.	7.599	229.	3557.	7.456	0.	0.	-35191.	-38636.
113	2	8	3.200	0.	0.	7.732	270.	229.	7.599	0.	0.	0.	0.
114	-1	8	3.200	0.	0.	7.841	0.	270.	7.732	0.	0.	5977.	5704.

CHANNEL REACH 9

115	3	10	7.412	6222.	10086.	7.268	-5973.	-10086.	7.325	0.	-3453.	0.	4156.
116	2	10	3.200	0.	0.	3.200	0.	0.	7.268	0.	0.	0.	0.
117	2	11	7.268	5973.	2157.	3.200	0.	0.	7.256	0.	3805.	0.	0.
118	-2	12	7.256	2157.	0.	3.200	0.	0.	7.268	0.	2082.	0.	0.

CHANNEL REACH 10

119	6	8	6.956	75150.	68077.	7.153	0.	0.	6.423	12809.	20123.	0.	0.
120	-7	8	6.906	0.	0.	6.423	68077.	78491.	3.390	0.	0.	3729.	-7978.

CHANNEL REACH 11

121	-7	5	7.191	-30606.	-53478.	7.135	0.	0.	7.239	-89976.	-75915.	0.	0.
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VOLUME OF WATER ABOVE MSL = 162254.6 MILLIONS OF CU FT  
(THE SEAPAD ROCS THRU JW 2 ARE EXCLUDED)





