United Nations Environment Programme

Estuary & Marine EFlows in RSA - information provided and uses for that information

Lara van Niekerk

our future through science

UNEP, Nairobi Convention

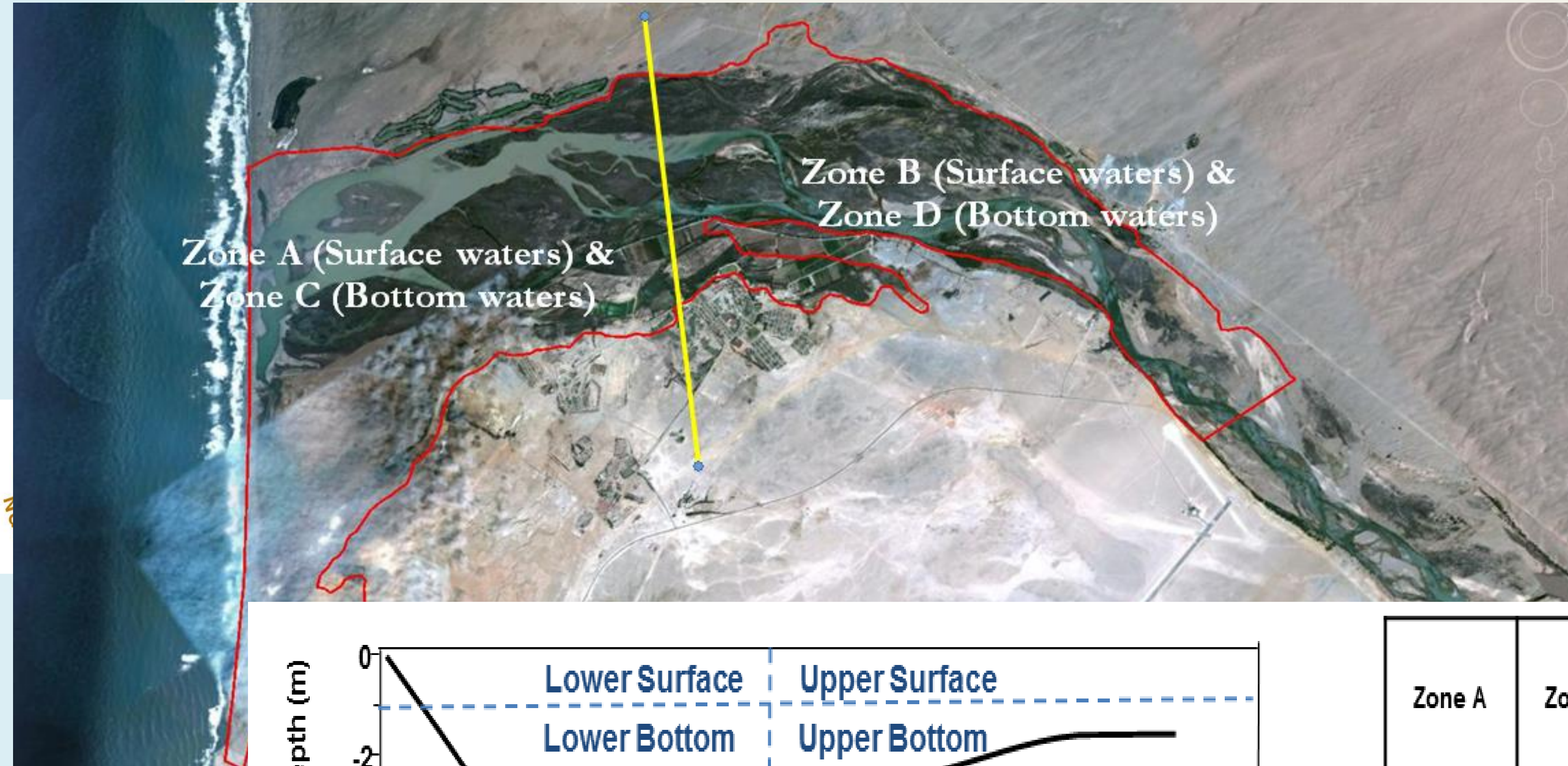
25th to 27th November 2019

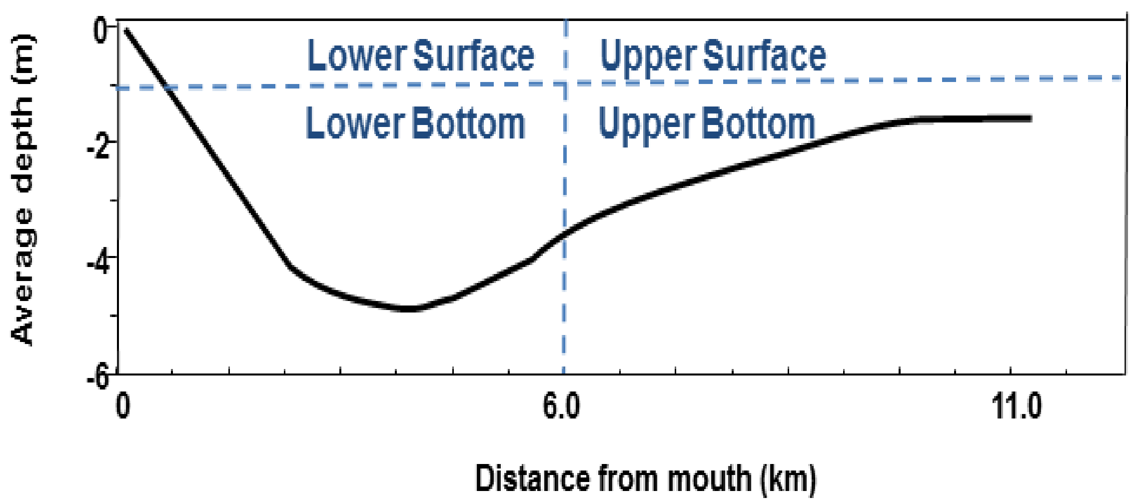
Cape Town

Orange Estuary

- Braided channels
- Islands
- Back water/Refuge areas
- Variety of habitat types
- Full salinity gradient
- High productivity

Zonation





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Zone A	Zone B
Zone C	Zone D

Pressures


Oppenheimer Bridge ~10km upstream

Sampling at Brandkaros (35 km upstream)

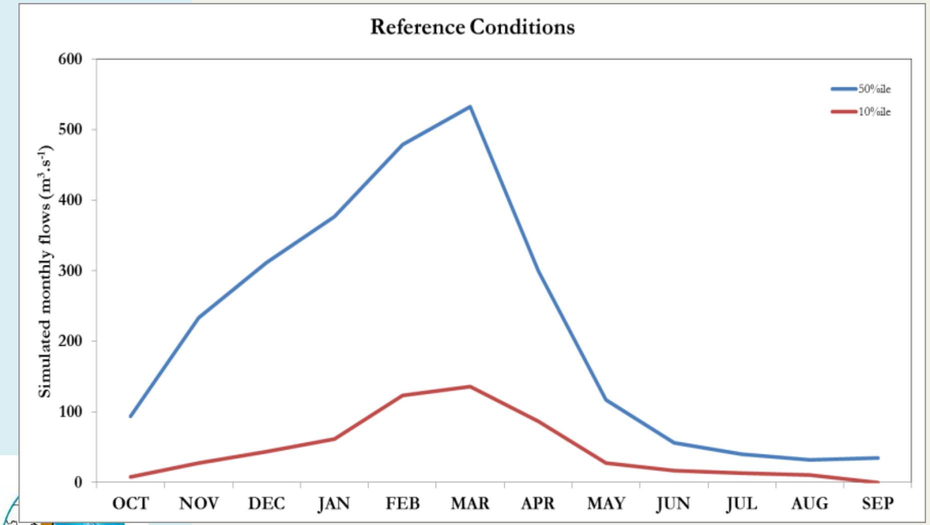
Abiotic States

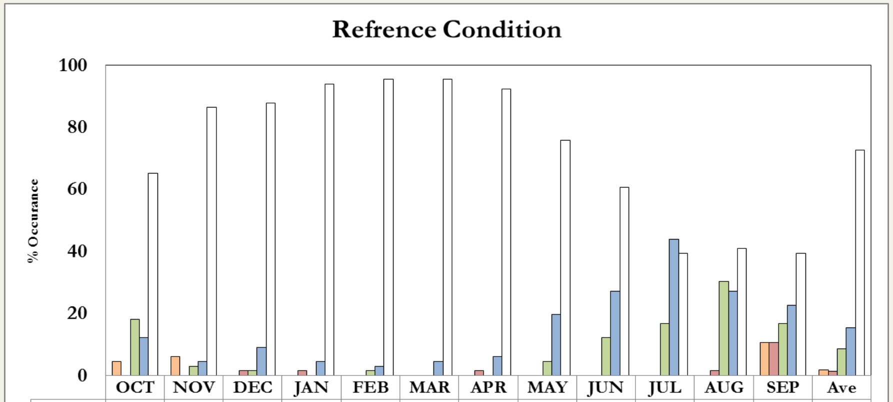
State	Description	Flow range (m^3/s)
1	Closed for extended period and hyper saline	0
2	Closed, with strong marine influence	0-5
3	Marine dominated (open mouth)	5-20
4	Brackish (open mouth)	20-50
5	Freshwater dominated (open mouth)	>50

Abiotic States

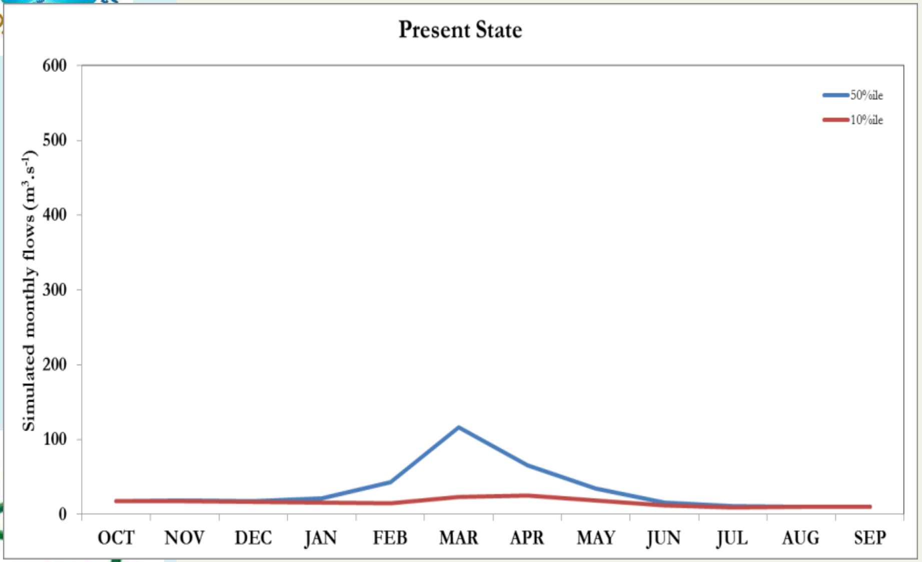
PARAMETER	STATE 1: HYPER SALINE	STATE 2: CLOSED	STATE 3: MARINE	STATE 4: BRACKISH	STATE 5: FRESH
Flow range (m^3/s)	0	0 - 5	5 - 20	20 – 50	>50
Mouth condition	Closed	Closed	Open	Open	Open
Water level variation	None	None	1.5 m	1.5 m	1.5 m
Inundation	None, very low water level	Intertidal and some of supratidal	Intertidal area	Intertidal area	Intertidal & Floodplain
Circulation	Wind mixing	Wind mixing	Tidal	Freshwater flushing and Tidal	Freshwater flushing
*Salinity (ppt)**	Reference 35 35 35 35 Future 45 35 45 35	25 10 30 15	20 0 30 5	5 0 25 0	0 0 5 0

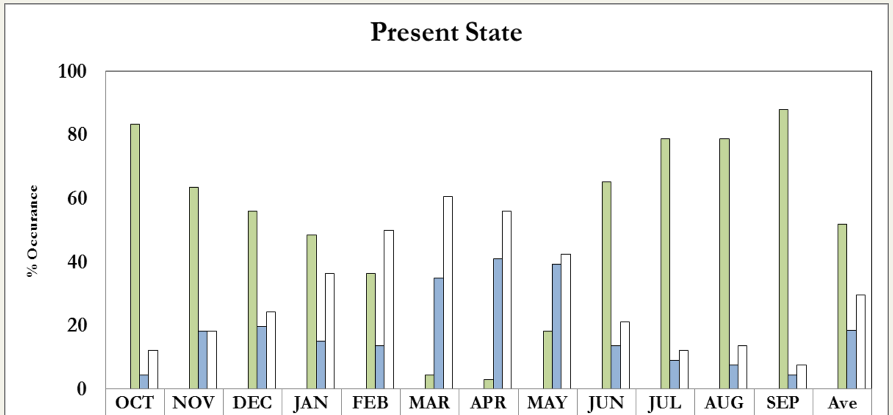
Abiotic States





	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Ave
State 1	5	6	0	0	0	0	0	0	0	0	0	11	2
State 2	0	0	2	2	0	0	2	0	0	0	2	11	1
State 3	18	3	2	0	2	0	0	5	12	17	30	17	9
State 4	12	5	9	5	3	5	6	20	27	44	27	23	15
State 5	65	86	88	94	95	95	92	76	61	39	41	39	73





	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Ave
State 1	0	0	0	0	0	0	0	0	0	0	0	0	0
State 2	0	0	0	0	0	0	0	0	0	0	0	0	0
State 3	83	64	56	48	36	5	3	18	65	79	79	88	52
State 4	5	18	20	15	14	35	41	39	14	9	8	5	18
State 5	12	18	24	36	50	61	56	42	21	12	[illegible]	[illegible]	[illegible]

Reference

YEAR	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Closed
1920	49.92	17.98	33.50	468.19	416.70	322.70	961.36	325.39	44.91	252.15	111.04	6.34	0
1921	64.81	310.23	144.52	53.70	478.22	306.96	74.27	23.01	15.79	13.45	4.80	29.69	1
1922	23.01	103.70	96.61	53.77	116.76	147.63	54.58	20.51	14.84	13.38	6.82	0.00	1
1923	0.00	1270.00	1292.29	*3455.42*	1852.31	1164.93	694.45	261.46	139.44	93.92	141.82	25.97	1
1924	156.42	1068.49	990.91	178.79	237.62	646.08	301.47	238.07	104.46	32.12	139.80	53.58	0
1925	6.57	40.42	79.82	249.57	277.33	389.77	356.01	382.61	140.25	48.60	23.43	1.37	1
1926	137.91	*2196.85*	656.46	1400.41	1907.08	552.00	120.71	29.53	24.75	20.46	10.92	0.00	1
1927	15.28	0.00	308.70	511.20	940.89	249.15	287.43	156.60	148.28	79.39	97.73	36.59	1
1928	306.97	184.61	437.87	874.11	*2116.92*	741.92	179.51	98.24	59.10	105.29	237.05	103.79	0
1929	278.56	622.20	298.39	156.34	360.04	704.14	476.13	327.08	131.07	48.74	23.00	244.39	0
1930	106.74	268.46	462.42	662.35	1226.76	349.08	282.80	79.17	26.66	32.93	23.71	25.41	0
1931	158.52	33.87	31.34	507.22	903.80	897.41	343.95	116.57	49.74	23.70	87.72	46.21	0
1932	217.39	370.33	1118.81	562.18	129.72	246.90	1317.83	1321.44	376.09	523.85	279.17	195.49	0
1933	760.91	*2010.47*	1629.23	790.79	*2316.41*	709.67	146.18	57.10	167.43	80.96	33.17	211.46	0
1934	292.87	176.08	17.52	24.66	234.43	983.34	309.70	67.13	48.20	28.16	12.33	0.00	1
1935	0.00	0.00	41.80	673.01	540.38	460.73	242.98	349.79	139.24	34.31	12.55	0.00	3
1936	274.41	225.86	84.10	127.51	300.14	229.74	264.84	104.86	54.88	35.55	19.53	129.58	0
1937	215.02	170.86	538.51	509.34	413.66	*2327.13*	904.54	107.19	38.15	20.34	10.33	0.69	1
1938	44.65	56.68	21.50	163.86	179.88	256.53	144.77	83.25	44.93	26.25	13.60	0.61	1
1939	41.61	326.33	612.63	299.52	688.96	1866.99	1820.26	861.16	235.29	125.68	329.80	146.55	0
1940	33.25	13.73	502.06	503.80	279.29	201.04	183.62	84.26	53.62	41.65	31.31	25.21	0
1941	602.18	188.03	73.36	174.12	821.54	371.00	118.34	47.73	41.32	265.50	149.20	65.82	0
1942	35.60	199.13	241.09	100.99	1520.39	654.17	385.47	154.44	48.57	24.38	18.72	9.52	0
1943	147.37	185.47	313.52	243.49	437.21	1936.27	947.09	117.48	56.22	27.46	10.26	0.00	1
1944	9.03	133.82	186.27	1519.74	*2726.45*	736.97	298.43	136.05	69.02	47.34	18.50	0.18	1
1945	42.01	241.92	398.62	272.86	1313.98	*2034.77*	1233.47	217.41	76.72	40.35	17.34	3.85	1
1946	148.37	377.41	1742.30	887.99	352.12	520.21	246.04	49.18	39.03	147.11	150.68	1926.21	0
1947	1933.13	682.13	373.66	1309.86	460.72	121.14	244.93	320.45	136.48	35.07	15.83	37.70	0
1948	19.32	257.41	503.24	254.21	282.32	156.60	425.52	647.05	185.69	161.45	79.12	14.34	0
1949	153.92	302.29	584.58	322.74	479.81	528.70	295.58	126.31	56.38	38.15	70.38	50.52	0
1950	124.63	290.21	693.57	383.80	160.73	1067.39	926.34	328.32	304.71	164.08	71.87	17.44	0
1951	8.15	487.56	609.23	205.50	1551.23	536.70	140.38	147.39	42.39	20.50	10.41	10.38	0
1952	6.09	497.81	243.60	1891.52	946.20	858.85	928.48	211.01	71.47	175.87	85.72	37.04	0
1953	60.62	712.16	386.46	378.62	168.16	544.13	389.52	59.40	56.88	64.27	52.05	51.81	0
1954	884.78	691.00	295.14	375.79	200.32	79.34	348.79	106.05	74.60	58.17	52.26	96.02	0
1955	86.09	111.06	35.75	1252.89	1091.16	125.33	37.19	24.36	16.27	9.17	6.47	0.00	1
1956	12.82	77.55	315.12	1934.85	*2273.69*	753.47	1349.07	596.57	381.47	95.85	44.53	26.55	0
1957	19.82	188.84	187.47	37.53	15.07	332.70	300.97	265.14	88.57	49.28	18.92	33.95	0
1958	7.61	22.11	280.99	68.94	219.85	625.25	450.82	186.46	93.40	31.75	21.63	0.15	1
1959	322.45	153.51	309.91	139.94	224.21	40.75	4.74	5.73	6.70	10.92	16.28	54.03	1
1960	265.78	154.92	428.78	432.07	536.09	225.94	481.72	225.72	54.57	39.00	23.42	18.39	0
1961	19.66	169.17	306.63	1013.01	1590.71	1769.19	684.17	219.09	65.38	31.36	20.34	7.65	0
1962	52.18	115.84	45.75	2.34	374.17	282.11	197.34	43.77	23.30	11.58	97.35	71.42	1
1963	79.69	127.42	351.33	*3533.90*	*5157.59*	*2985.24*	874.58	366.11	174.52	63.54	429.10	101.99	0
1964	18.02	801.90	699.30	782.91	*2312.85*	1285.41	473.22	118.82	63.06	89.53	44.48	99.53	0
1965	183.15	585.17	1248.61	*3005.76*	*3506.52*	*3877.99*	1786.64	728.96	281.88	144.46	81.87	128.27	0
1966	1373.23	868.11	225.59	342.17	1707.10	1184.98	335.26	109.49	56.17	39.23	21.65	85.83	0
1967	307.39	190.54	219.55	1261.43	704.27	630.56	1101.26	257.71	90.77	59.68	41.51	158.94	0
1968	214.22	79.13	656.46	222.24	349.04	202.78	41.74	46.20	53.62	86.67	422.94	274.74	0
1969	299.28	209.76	257.55	244.83	530.46	465.14	209.36	25.55	15.99	15.91	92.87	145.01	0
1970	95.62	211.29	297.49	893.35	1063.00	683.29	140.13	112.00	182.12	44.79	258.10	249.50	0
1971	61.60	123.63	339.74	164.55	81.50	115.00	494.54	194.99	65.16	61.90	38.27	22.27	0
1972	176.83	348.71	55.42	26.48	22.89	32.18	43.77	47.53	46.84	59.18	45.32	12.86	0
1973	92.01	460.32	519.70	496.97	109.06	146.23	151.95	113.38	30.18	21.05	29.23	64.94	0
1974	71.64	123.19	80.42	118.01	654.08	348.24	99.08	18.42	22.52	15.28	8.10	0.00	1
1975	121.07	470.96	874.38	428.34	324.56	165.79	130.55	43.46	71.39	27.03	27.13	105.10	0
1976	355.38	992.29	193.99	126.77	179.84	178.90	179.36	41.68	14.67	13.75	80.82	1476.83	0
1977	1401.73	764.68	568.13	332.09	*3828.65*	*3849.40*	926.51	226.89	143.04	111.84	119.82	537.36	0
1978	653.82	465.44	725.24	895.19	*2170.75*	770.16	352.19	208.17	241.32	136.23	156.75	22.38	0
1979	32.17	398.42	378.51	205.62	209.09	656.60	663.10	275.89	92.09	99.67	68.46	46.21	0
1980	7.63	0.00	82.38	1182.43	1407.54	964.46	259.45	41.92	32.41	27.78	24.09	39.76	1
1981	1364.79	545.41	243.70	78.04	37.57	47.53	24.97	5.23	7.13	6.85	16.06	15.38	0
1982	53.53	487.93	97.12	51.76	322.26	201.33	183.87	77.96	16.87	10.11	15.75	0.24	1
1983	703.39	350.89	393.27	874.66	1493.41	323.04	301.80	108.23	29.28	26.24	25.04	7.56	0
1984	0.00	0.00	1.00	80.14	86.82	275.59	192.31	67.62	29.01	14.34	18.33	9.69	3
1985	81.83	365.72	1609.86	1253.59	*2297.69*	1158.84	222.75	117.42	58.65	92.14	76.74	35.65	0

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State 1 0.00 State 2 0.0-5 State 3 5-20 State 4 20-50 State 5 >50 Floods > 2000

Present

YEAR	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Closed
1920	17.29	17.47	16.84	22.55	26.41	46.38	59.59	21.55	13.60	66.14	61.48	10.09	0
1921	17.43	20.32	16.58	16.47	10.62	23.96	27.27	19.97	13.43	10.19	10.11	10.07	0
1922	9.14	17.49	16.94	17.20	16.47	23.00	25.78	17.90	11.75	9.00	9.70	10.04	0
1923	17.14	19.92	35.58	1216.68	1024.35	581.79	364.92	115.23	63.44	14.69	10.53	10.23	0
1924	18.73	345.93	662.44	20.29	30.66	162.11	139.35	191.87	51.28	10.95	62.38	10.05	0
1925	17.25	17.89	16.46	16.42	14.97	107.08	107.50	159.15	39.90	10.30	10.23	10.63	0
1926	17.75	830.02	190.40	788.19	1401.11	268.36	59.27	20.11	13.43	10.19	10.13	10.02	0
1927	17.14	17.54	20.41	30.84	72.93	29.45	20.35	32.22	16.74	11.10	10.36	10.03	0
1928	17.46	10.15	31.25	68.00	1475.30	414.16	79.62	24.83	14.59	12.62	133.37	51.13	0
1929	19.72	192.82	132.67	19.95	55.51	75.35	230.38	216.07	35.06	11.15	10.15	16.60	0
1930	18.60	21.84	129.74	293.04	490.63	134.27	118.73	50.94	14.66	10.46	10.36	10.04	0
1931	17.53	16.92	16.35	16.42	140.89	161.05	43.32	36.14	18.19	10.51	10.71	10.02	0
1932	26.16	20.22	198.30	189.27	19.09	26.88	920.20	1256.11	308.19	406.93	145.71	39.47	0
1933	394.88	1712.55	1344.68	392.46	*2111.18*	500.52	31.51	20.26	30.29	11.27	10.54	10.09	0
1934	97.47	36.06	16.35	17.01	15.03	277.42	84.56	20.14	13.39	10.80	10.26	10.04	0
1935	17.90	17.55	20.62	23.99	16.20	27.70	58.75	31.46	15.37	10.24	10.15	10.46	0
1936	17.52	17.48	16.37	15.89	14.82	16.52	32.30	19.31	11.71	9.16	10.13	10.03	0
1937	17.46	17.31	17.63	15.70	16.67	608.60	741.25	43.44	34.57	10.30	10.18	10.02	0
1938	17.35	17.71	17.58	9.15	12.71	25.89	35.89	19.38	12.04	9.35	9.75	10.04	0
1939	17.18	16.96	16.37	16.42	127.84	411.96	403.28	807.29	203.94	67.47	206.76	20.44	0
1940	19.21	17.50	36.46	34.17	25.44	32.16	25.98	21.38	15.30	10.74	10.17	10.02	0
1941	17.48	17.09	18.37	16.42	129.98	114.52	28.12	18.61	11.46	89.53	37.59	10.07	0
1942	17.56	18.70	16.87	16.42	113.39	117.44	35.03	25.10	13.35	10.21	10.61	10.16	0
1943	17.36	18.97	47.22	34.54	10.08	532.89	567.11	45.30	16.77	10.99	10.39	10.06	0
1944	17.19	17.40	16.43	135.69	*2024.84*	509.13	190.81	57.33	18.29	14.06	10.61	10.16	0
1945	17.82	22.44	21.08	16.98	224.63	1183.07	728.59	140.80	20.33	11.95	10.99	10.02	0
1946	17.53	18.23	890.15	500.40	64.98	180.77	112.25	24.93	16.13	19.40	10.63	1511.09	0
1947	1580.75	410.63	104.10	869.26	193.46	26.86	66.03	190.61	83.30	11.30	10.11	10.02	0
1948	17.12	17.63	23.01	24.97	20.71	24.45	26.94	221.43	110.52	93.33	16.92	10.02	0
1949	17.33	17.95	16.66	16.54	30.30	199.10	118.75	63.53	14.10	10.69	15.59	10.03	0
1950	17.36	17.84	94.17	87.70	14.98	346.39	670.47	235.81	236.49	90.73	33.10	10.07	0
1951	17.14	22.88	11.52	19.18	948.63	335.38	21.87	132.60	16.90	10.85	11.03	10.40	0
1952	17.17	20.58	18.08	486.32	418.55	599.62	745.60	137.13	31.29	51.51	24.29	10.19	0
1953	17.81	59.06	112.39	16.50	14.80	129.07	243.38	18.01	11.58	18.87	10.00	11.19	0
1954	132.19	277.42	137.62	130.13	14.55	50.05	41.98	22.62	13.08	10.27	10.20	10.02	0
1955	17.25	17.75	16.10	66.49	510.57	21.36	16.13	20.27	13.29	10.12	10.11	10.02	0
1956	19.97	19.00	16.91	209.73	1620.83	447.98	1268.68	660.67	279.28	45.52	11.38	10.13	0
1957	17.76	15.04	21.53	16.42	14.80	106.00	65.80	56.80	26.98	10.37	10.24	10.02	0
1958	17.47	14.60	12.14	16.45	57.98	42.06	35.84	22.89	14.28	10.28	10.27	10.02	0
1959	17.58	17.10	16.35	16.42	20.01	27.42	24.20	18.11	11.80	8.80	10.41	10.03	0
1960	10.89	18.93	17.42	14.98	26.39	33.81	29.87	21.36	13.57	17.63	12.93	10.09	0
1961	17.66	17.25	16.35	124.36	166.68	324.05	293.53	131.51	14.49	10.25	10.18	10.02	0
1962	17.19	17.39	16.35	16.42	23.38	48.72	48.53	23.41	13.44	10.83	10.21	10.05	0
1963	18.56	18.04	25.74	1237.94	*3499.19*	*2243.30*	551.83	175.38	53.31	16.24	138.01	30.85	0
1964	17.94	108.84	337.75	455.50	1953.54	872.27	289.35	63.57	16.90	32.02	10.30	10.06	0
1965	17.24	18.02	676.71	*2108.52*	*2903.04*	*3205.76*	1451.27	540.92	163.66	46.98	17.30	11.51	0
1966	669.80	530.32	54.67	114.99	879.57	833.72	151.62	66.69	16.29	10.45	9.90	9.90	0
1967	17.92	21.75	17.90	452.17	299.64	504.90	867.42	165.90	39.59	13.98	10.41	10.14	0
1968	18.02	17.34	16.38	24.04	77.85	39.62	25.31	19.63	16.45	12.62	42.64	17.28	0
1969	17.49	17.93	16.39	16.42	16.61	92.61	102.59	20.36	13.10	9.94	89.08	72.16	0
1970	27.74	23.92	18.32	38.42	223.37	393.65	30.62	48.84	85.65	10.14	145.89	102.20	0
1971	17.47	18.76	19.16	16.43	14.87	21.06	35.50	20.93	12.21	12.21	10.26	10.02	0
1972	17.77	17.63	13.74	16.59	14.82	21.10	18.97	21.40	11.96	8.79	9.62	10.06	0
1973	17.55	20.58	13.22	16.52	14.95	18.99	22.81	18.97	11.47	9.09	10.16	10.02	0
1974	17.69	17.77	16.35	15.44	22.40	22.90	33.87	18.43	11.46	8.79	10.10	10.02	0
1975	20.92	24.01	53.29	52.04	7.71	28.69	42.57	21.59	35.44	16.01	9.69	10.06	0
1976	17.69	17.89	16.35	16.42	7.47	28.08	28.85	20.06	11.46	9.00	9.70	11.25	0
1977	382.11	132.70	39.46	8.70	*3156.35*	*3368.39*	742.90	150.10	92.82	39.23	42.01	273.47	0
1978	190.67	162.74	371.87	546.80	1903.18	518.10	248.68	124.16	140.02	51.08	63.37	10.06	0
1979	17.15	18.00	16.40	16.45	17.70	212.71	452.94	163.69	55.35	45.72	10.14	10.02	0
1980	17.13	16.96	17.18	188.31	882.95	690.03	120.56	42.28	15.44	11.20	11.44	11.57	0
1981	570.82	363.53	41.00	15.20	14.80	19.26	24.83	17.85	11.46	8.81	10.13	10.19	0
1982	17.43	18.12	16.35	16.47	18.18	26.08	35.76	18.52	10.46	9.44	10.15	10.02	0
1983	18.30	19.23	16.40	23.67	105.04	56.68	113.41	65.14	13.42	10.69	10.14	10.02	0
1984	17.16	17.39	16.35	14.65	14.89	28.58	33.70	21.26	14.29	11.49	11.51	10.67	0
1985	18.06	20.17	36.18	667.42	1465.40	416.81	136.63	101.42	14.46	28.78	13.38	7.79	0

0

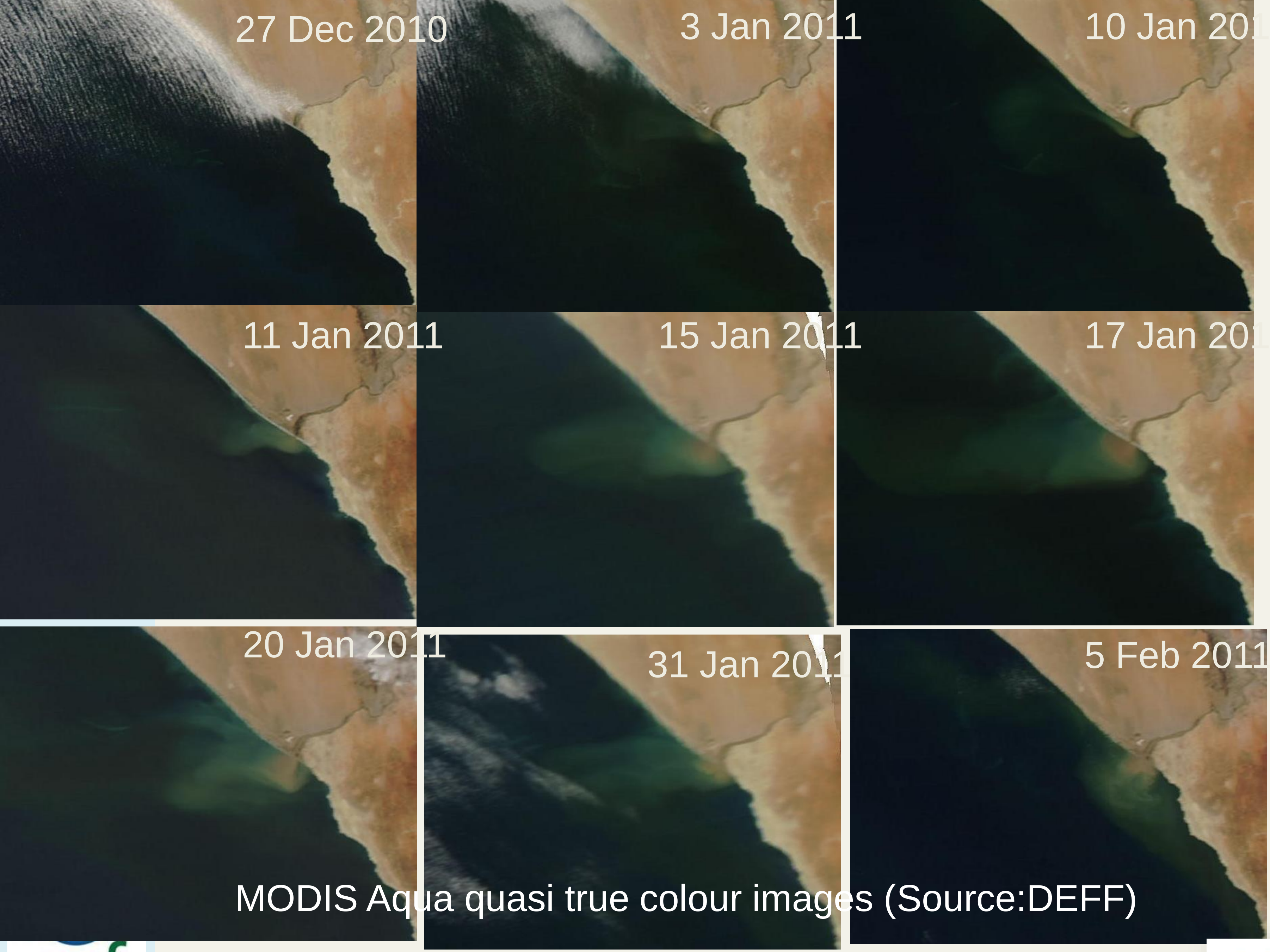
State 1	0.00	State 2	0.0-5	State 3	5-20	State 4	20-50	State 5	>50	Floods	> 2000

Conclusions

- Reserve process accurately predicted the estuary life cycle
- Accuracy of flow data a major short coming
- Stop base flow & hydro releases: Increase mouth closure
    - Back-flooding in saltmarshes
- Still needs higher flows and floods to reset
- Vioolsdrift Dam with high wall: Different type of estuary!!!

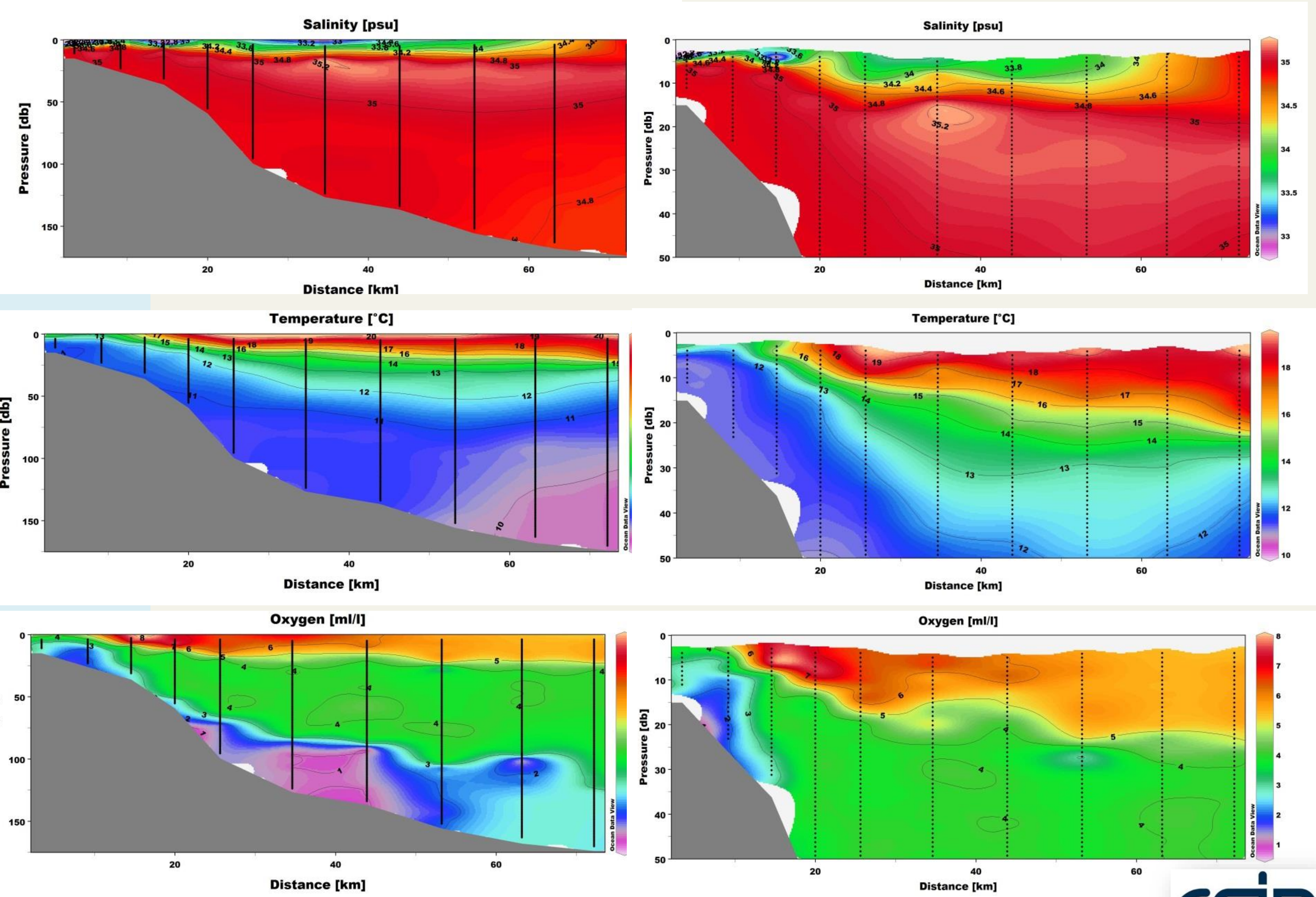

CSIR

Orange River Nearshore Environment

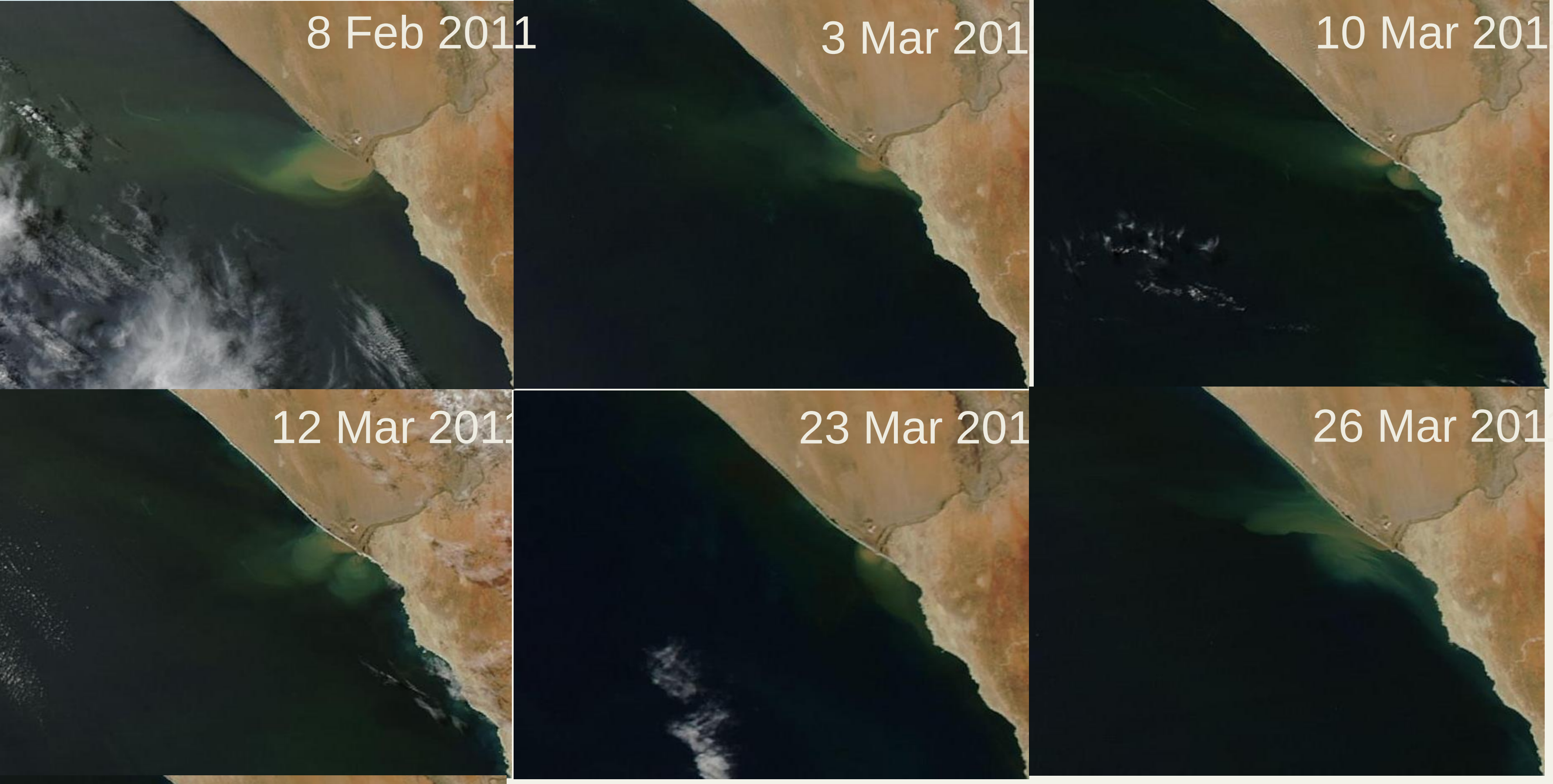


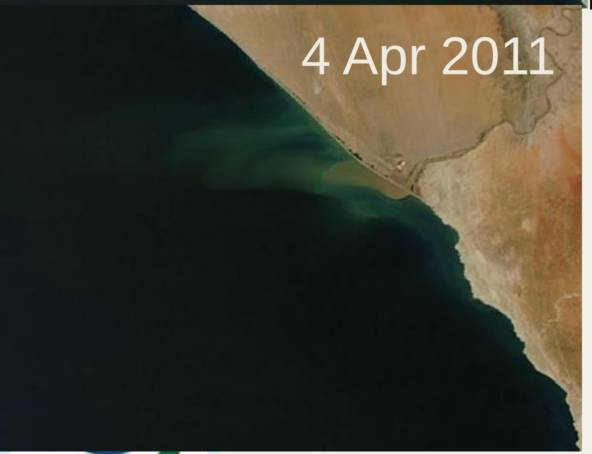
MODIS Aqua quasi true colour images (Source:DEFF)

Example: 2010/2011flood event (1: 20 yr)



Sampled on 4 & 5 Feb 2011 during 2010/11 flood



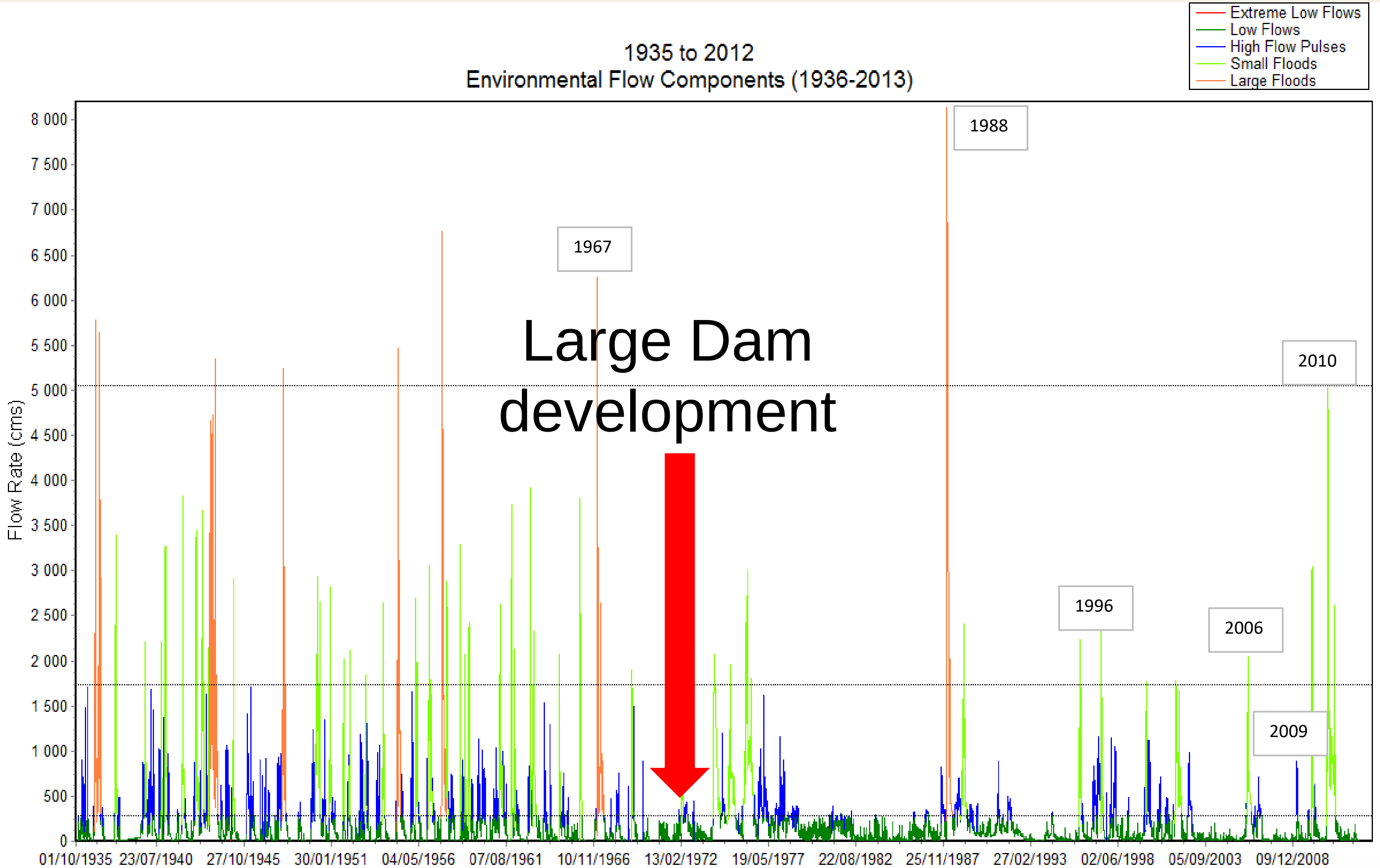


- Residual turbidity plume still event 2 month after the flood subsided
- Due to wave action reworking the nearshore sediment deposits

River load: higher silt content prior to major dam construction till 1970s
After which higher clay fraction due to trapping of coarser fractions by dams

2011 flood (1:20yr event) still carried large sediment load & resulted in large plume off the mouth, but both would have been much more under Reference state…

- Significant reduction in sediment deposition which will have lead to coastal erosion
- Off set by Namdeb mining pushing out coast
- Still assist in maintain a more natural sediment composition (fines vs coarse)



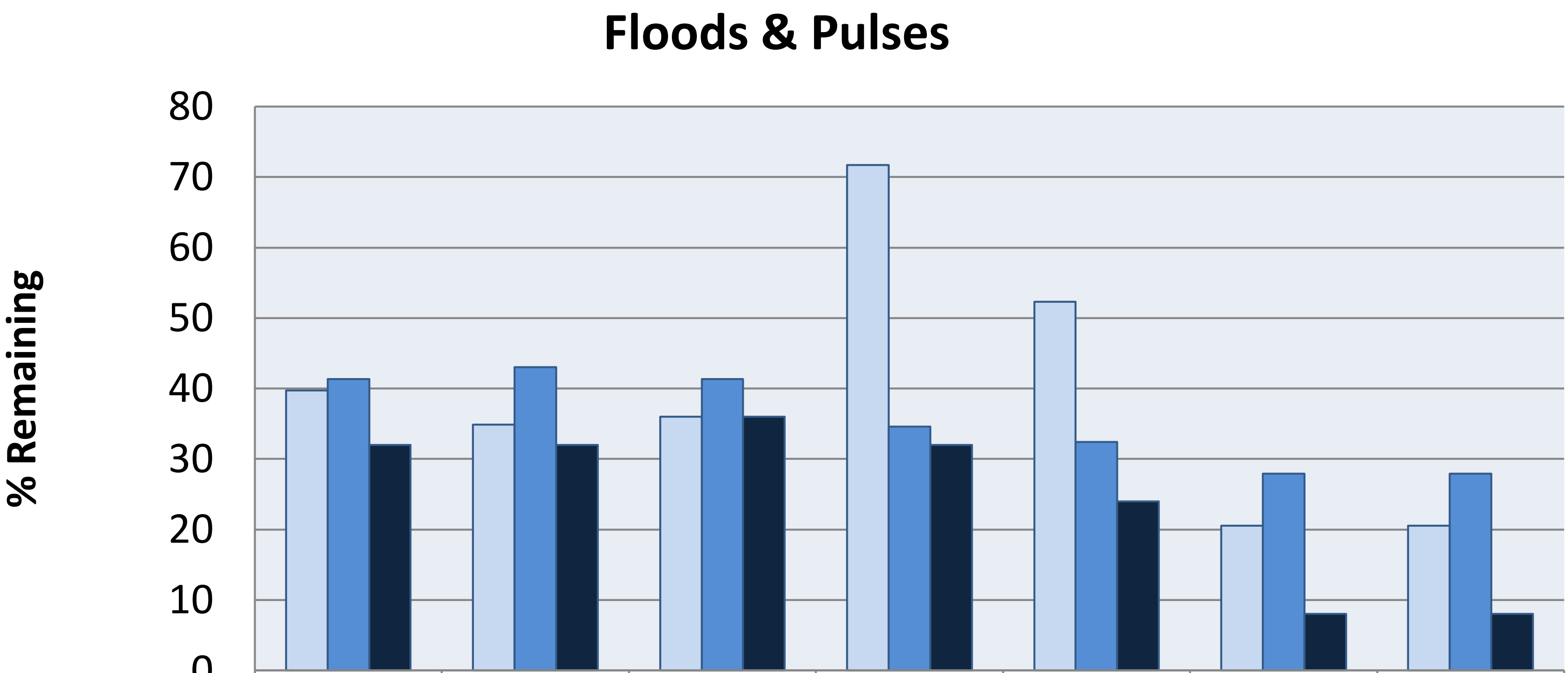
1935 to 2012
Environmental Flow Components (1936-2013)
Extreme Low Flows
Low Flows
High Flow Pulses
Small Floods
Large Floods
Flow Rate (cms)
8 000
7 500
7 000
6 500
6 000
5 500
5 000
4 500
4 000
3 500
3 000
2 500
2 000
1 500
1 000
500
0
01/10/1935
23/07/1940
27/10/1945
30/01/1951
04/05/1956
07/08/1961
10/11/1966
13/02/1972
19/05/1977
22/08/1982
25/11/1987
27/02/1993
02/06/1998
05/09/2003
09/12/2008
1967
1988
2010
1996
2006
2009
Large Dam development

Scenarios

Occurrences in 66 years									
		Natural	Present	Sc2	Sc3	Sc4	Sc5	Sc6a	Sc6
Inside Estuary	< 150	238	571	585	583	471	545	668	668
Pulse	150-1000	350	139	122	126	251	183	72	72
Small floods	1000-5000	179	74	77	74	62	58	50	50
Large Floods	>5000	25	8	8	9	8	6	2	2

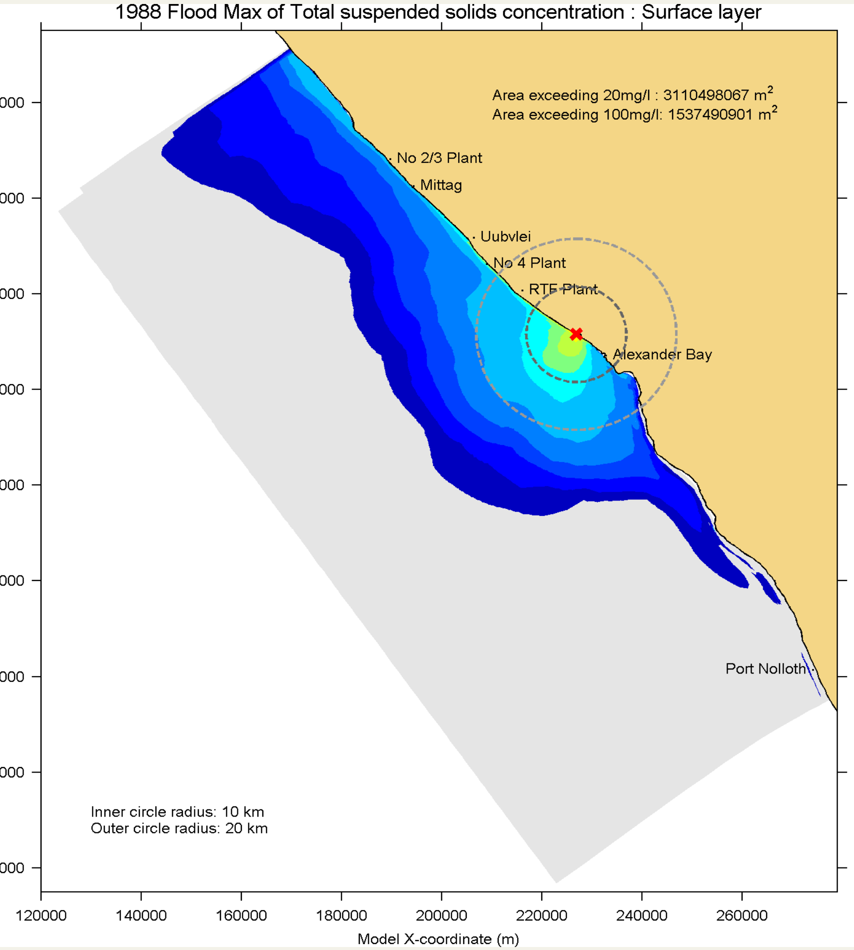
% Occurrences in 66 years									
		Natural	Present	Sc2	Sc3	Sc4	Sc5	Sc6a	Sc6
Inside Estuary	< 150	30	72	74	74	59	69	84	84
Pulse	150-1000	44	18	15	16	32	23	9	9
Small floods	1000-5000	23	9	10	9	8	7	6	6
Large Floods	>5000	3	1	1	1	1	1	0	0

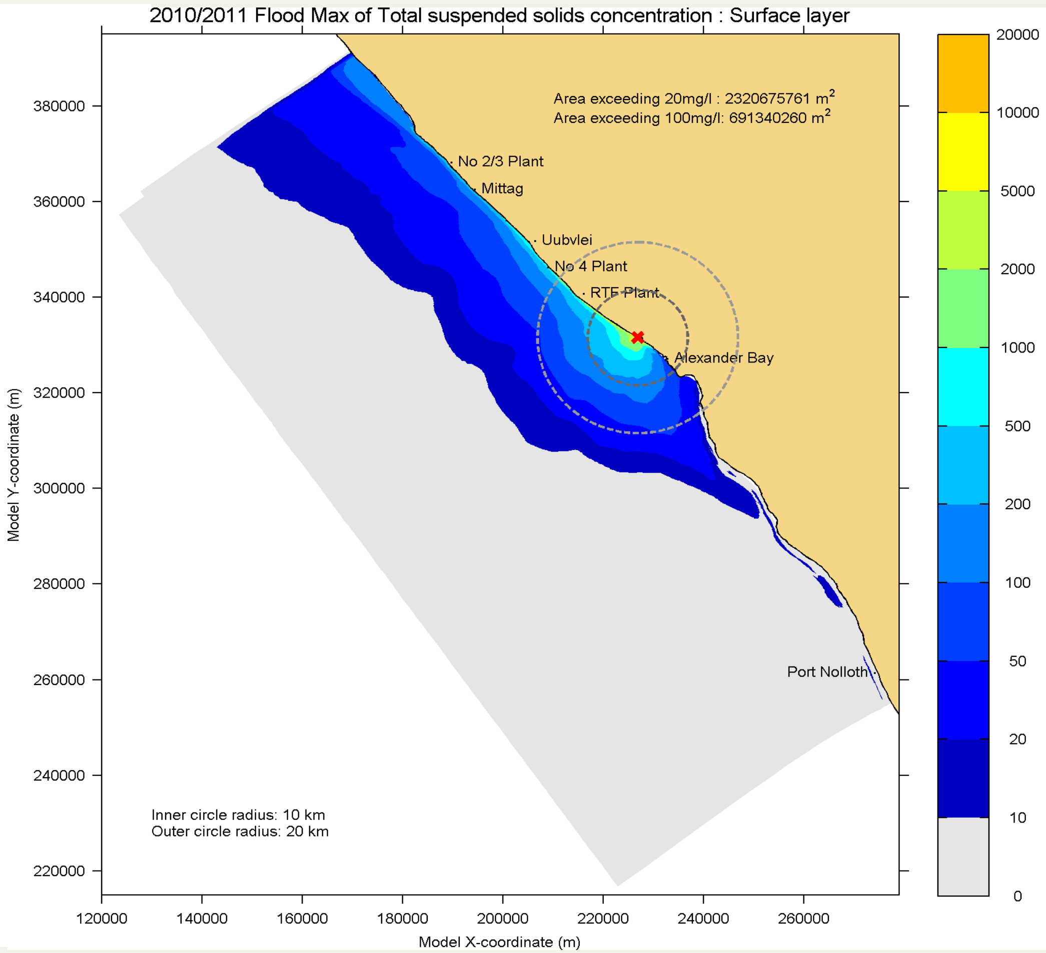
Scenarios



	Present	Sc2	Sc3	Sc4	Sc5	SC6a	Sc6
150-1000	40	35	36	72	52	21	21
1000-5000	41	43	41	35	32	28	28
>5000	32	32	36	32	24	8	8

Model Results: Surface Turbidity (max)

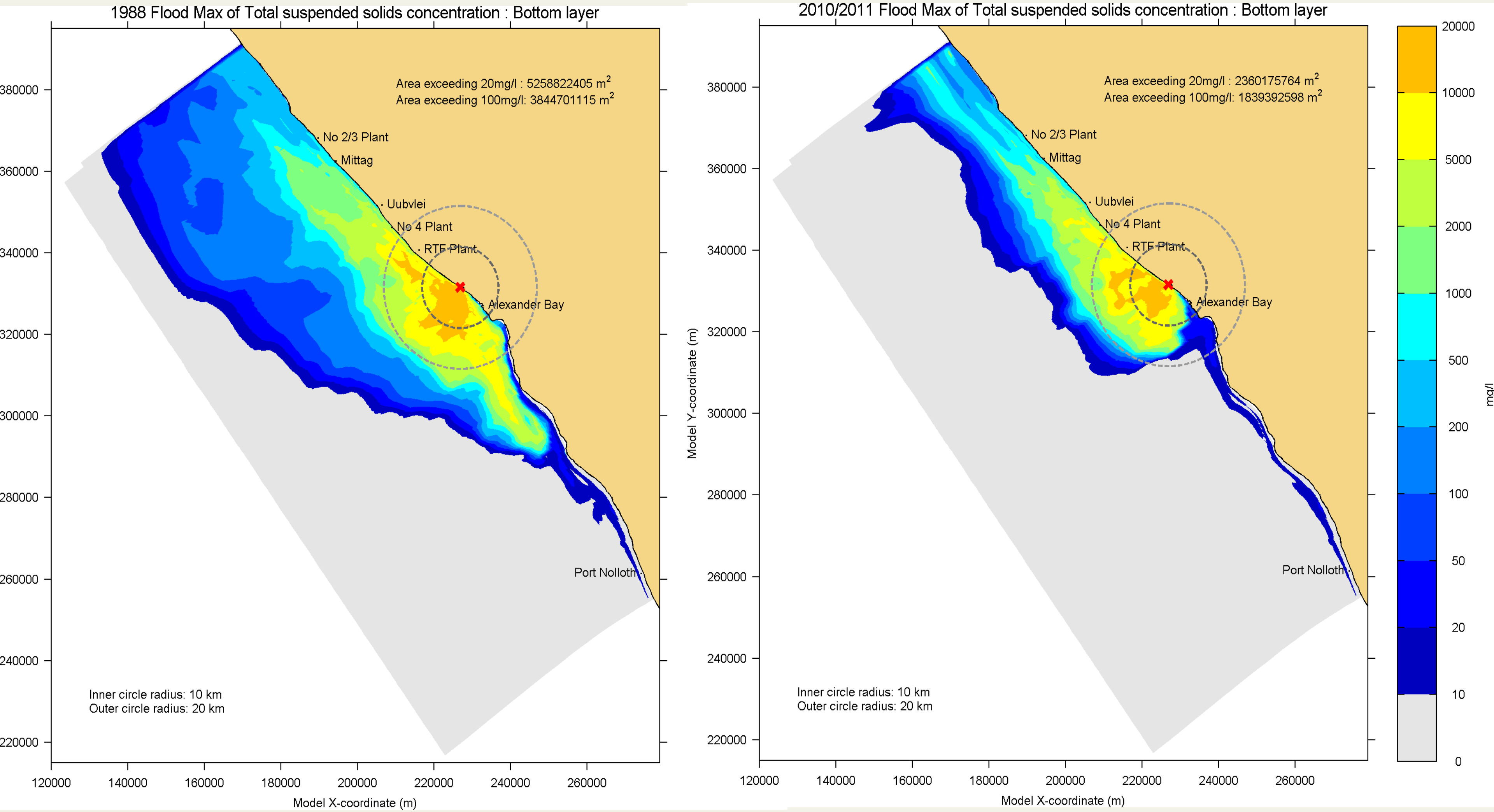




1988 (1:100 yr event)

2010 (1:20 yr event)

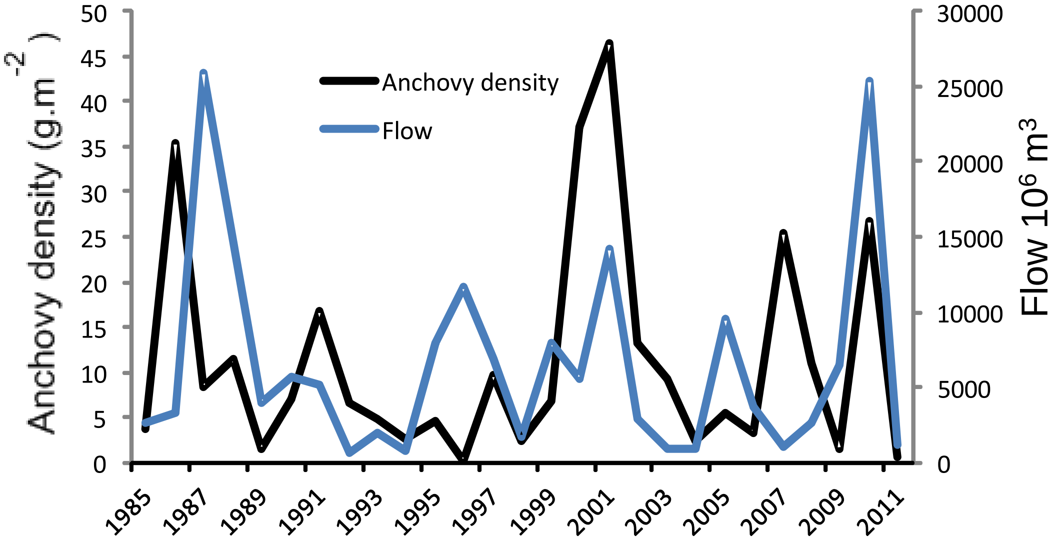
Model Results: Bottom Turbidity (max)

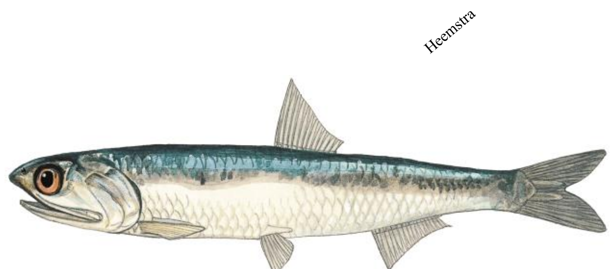


1988 (1:100 yr event)

2010 (1:20 yr event)

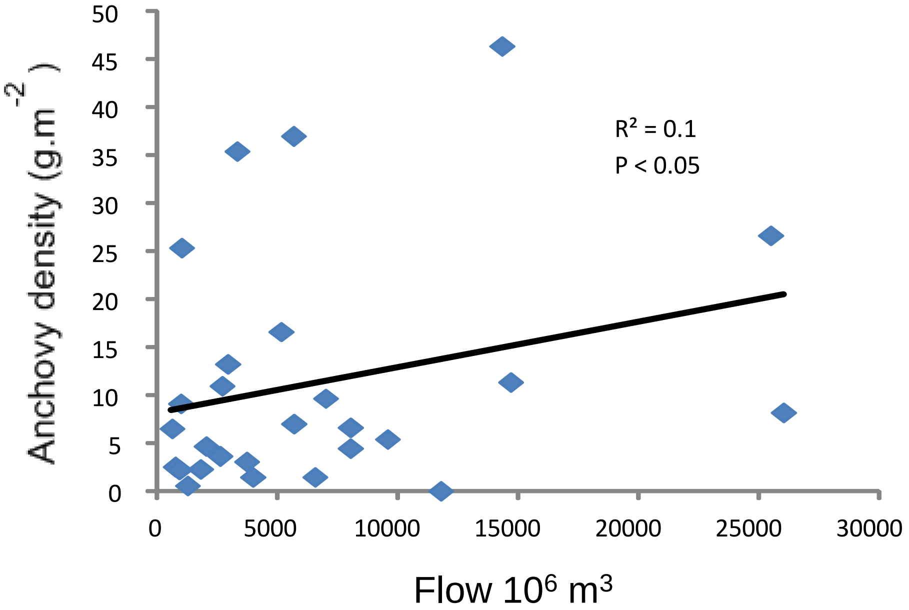
Juvenile anchovy density vs Orange monthly flow volumes





Engraulis encrasicolus

- Anchovy, sardine & round herring are important pelagic purse-seine fishery on SA & Namibian coast
- 400 – 600 000 tons per annum
- Only anchovy show positive relationship



Change ratings

Significance Rating	Metric reported as a % of the magnitude of change from Reference	Comment
3	175% to 200%	Highly significant increase
2	150% to 175%	Moderately significant increase
1	125% to 150%	Discernible increase
0	75% to 125%	Minimal change
-1	50% to 75%	Discernible decrease
-2	25% to 50%	Moderately significant decrease
-3	0% to 25%	Highly significant decrease

Degree of change for future scenarios

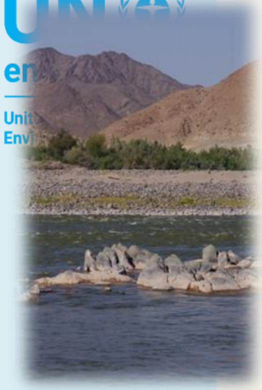
- Freshwater, dissolved reactive silicate (DRS), turbidity and sediment inflows to the nearshore marine environment under the various proposed future scenarios .
- The inflows for the various scenarios are expressed in terms of the significance ratings specified relative to reference conditions.

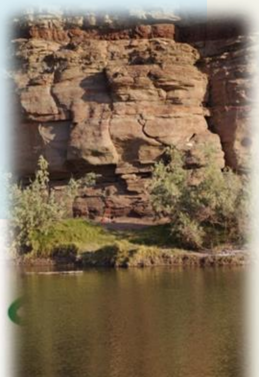
Time line	Scenario	Total freshwater discharge volume	Total Discharge of Sediments (annual average of 66-year period)			
			Salinity	DRS	Turbidity	Sediments
<120 yrs	Reference	0	0	0	0	0
2010	Present	-2	-2	-2	-2	-2
Near future <2030	Scenario 2	-2	-2	-2	-2	-2
	Scenario 3	-2	-2	-2	-2	-2
	Scenario 4	-2	-2	-2	-1 / -2	-2
	Scenario 5	-2	-2	-2	-2	-2
Far Future >2030	Scenario 6	-3	-3	-3	-3	-3
	Scenario 7	-3	-3	-3	-3	-3

UN environment United Nations Environment Programme

Assessment of the responses of the key ecosystem services /biotic component to predicted abiotic changes under the various flow scenarios

Component	Natural -120 yrs	Present 2010	Near future < 2030				Far future >2030	
			Sc2	Sc3	Sc4	Sc5	Sc6	Sc7
Phytoplankton	-2	+2	+2	+2	+3	+2	+3	+3
Macrophytes	-3	0	0	0	-1	0	+3	+3
Habitat-forming macrophytes (kelps)	-3	0	0	0	-1	0	+3	+3
Soft-sediment macrofauna	+3 ?	0	0	0	+1 ?	0	-1 ?	-1 ?
Reef-associated macrofauna	-3	0	0	0	-1	0	+3	+3
Rock Lobster	-3	0	0	0	-1	0	+3	+3
Benthic biodiversity	-3	0	0	0	-1	0	+3	+3
Nomadic coastal fish (e.g. kob)	+3	-2	-2	-2	-1	-2	-3	-3
Demersal soft sediment fish (e.g. sole)	+3	-3	-3	-3	-3	-3	-3	-3
Small-pelagic fish (e.g. anchovy)	+3	-2	-2	-2	-1	-2	-3	-3
Intertidal, subtidal, surf-zone fish	+3	-1	-1	-1	0	-1	-1	-1





Marine : eflows

Based on model simulations & review on the responses of marine flora and fauna to the abiotic drivers:

- Present, scenarios 2, 3 and 4: Not possible to discern changes in biotic components
- Scenario 5: slight changes may be expected
- Scenarios 6 and 7: significantly different

Increase in marine benthic biodiversity in the vicinity of the river mouth, as the **abiotic stressors decline** or are removed entirely should the mouth remain closed for extended periods of time. **Marine communities are expected to become more similar to those in West Coast habitats not influenced by river inflows.**

Take home message

Water flowing into to sea is not wasted!!!!

River floods flowing into the sea provides a number of crucial functions:

- Sediment supply to beaches & nearshore habitat
- Nutrient supply
- Salinity fronts
- Turbidity frons

Flow is important for:

- Maintaining the beaches.
- Maintaining structural & water column habitat
- Biodiversity – fresh water flow is a stress (Lamberth et al 2014)