Supplementary information

S1. Geometric and water level measurements (Obtained from Dr. Rodrigues through personal communication)

Table S1. Width data and Initial Bathymetry of Tyne river

Distance from Tidal Limit (km)	Width (m)	Initial Bathymetry (m)
0	71.5	0.495
0.5	76.9	0.608
1	102	0.863
1.5	124	1.050
2	124	1.087
2.5	134	1.117
3	136	1.213
3.5	126.3	1.712
4	134	2.338
4.5	130	2.333
5	130	2.137
5.5	130	2.040
6	152.7	2.139
6.5	138	2.448
7	114.6	2.512
7.5	124	2.543
8	149.3	2.603
8.5	194.9	2.677
9	155.6	3.058
9.5	145	3.073
10	170.7	2.503
10.5	173	2.116
11	216.1	1.886
11.5	240.1	1.727
12	235.82	1.781
12.5	283.73	1.914
13	223.91	2.466
13.5	176.18	3.391
14	212.64	4.018
14.5	163	5.087
15	123	6.373
15.5	129	6.754
16	143	7.038
16.5	121	7.167
17	173	6.671
17.5	155	6.510

18	153	6.403
18.5	199	6.340
19	165	6.647
19.5	215	6.027
20.5	188	5.571
21	203	5.723
21.5	205	5.461
22	218	5.482
22.5	253	5.784
23	250	5.889
23.5	228	6.044
24	256	6.196
24.5	274	6.134
25	280	6.193
25.5	293	6.557
26	288	7.671
26.5	385	8.918
27	353	9.267
27.5	354	9.246
28	279	8.935
28.5	430	8.497
29	328	8.737
29.5	288	9.235
30	255	8.102
30.5	637.8	6.600
31	968.4	6.784
31.5	842.4	7.086
32	408	7.000

S2. Tide Components (Obtained from Dr. Rodrigues through Personal Communication)

6 component tide. i = 1, 2, ..., 6

Water elevation at downstream boundary, WL = TC(1) + TC(2) + TC(3) + TC(4) + TC(5) + TC(6).

Where TC is the tide component, expressed as TC(i) = AMP(i)*cos((PHASE(i)−Freq (i)*T*24)*π/180).

i= 1, 2, ..., 6. Where T is the time (days), AMP is the tide amplitude (meters), Freq is its frequency (degrees per hour) and PHASE its phase (degrees). The respective arguments are shown in the tables below:

Table S2. Harmonic components of the tide

i	AMP	Freq	PHASE
1	1.476	29.12	42
2	0.518	30	144
3	0.115	15	40
4	0.11	14.07	250
5	0.009	57.9684	271
6	0.001	86.9526	118

S3. Reaction Kinetics:

Current study adopts reaction kinetics adopted in the Rodrigues et al. (2007). P1 Ammonification (generation of ammonia) from the bed sediment, P2 Algal uptake of ammonia, P3 Nitrification and P4 Emission of nitrous oxide into the atmosphere. Nitrous oxide sources are specified as water column nitrification. Because of the prevailing DO, water column denitrification was not favored and so is not considered in this study. Because the unavailability of bacterial data information, microbial growth kinetics and lower measured concentration below half saturation constant showing a linear interaction between rate of reaction and ammonium concentration, the rate of nitrification is parameterized by a single rate constant. Rate constants at a give temperature may be represented as:

$Rate\ constant\ at\ T^0C = Rate\ constant\ at\ 20^0C * \emptyset 1^{T-20}$; $\emptyset 1$ is Arrhenius coeffcient.

S4. Field inputs for the simulation (Obtained from Dr. Rodrigues through personal communication)

Table S3. Field measured inputs for Tyne River

Position from Tidal Limit, km	Water, m^3/s	NH_4^+ (kg/day)	N_2O (kg/day)	NO_3^- (kg/day)
0	10	Meas.conc. **	Meas.conc. **	Meas.conc. **
10	2.51	25	0.003	0
13	0.26	60	0.0003	0
23	0.3	9000	0.0004	0
27	0.26	19	0.0003	0

** measured from Rodrigues et al. (2007)

S5. Calibrated components of longitudinal dispersion coefficients:

Table S4. Longitudinal dispersion coefficient components

Distance from Upstream, km	$D_{x,avg}$ (x), m²/s	Amplitude, A(x)	Phase Angle φ
0	180.00	100	184.06
0.1	179.33	100	187.44
0.2	178.67	100	190.82
0.3	178.00	100	194.20
0.4	177.33	100	197.58
0.5	176.67	100	200.95
0.6	176.00	100	204.33
0.7	175.33	100	207.71
0.8	174.67	100	211.09
0.9	174.00	100	214.47
1	173.33	100	217.85
1.1	172.67	100	221.23
1.2	172.00	100	224.61
1.3	171.33	100	227.98
1.4	170.67	100	231.36
1.5	170.00	100	234.74
1.6	169.33	100	238.12
1.7	168.67	100	241.50
1.8	168.00	100	238.12
1.9	167.33	100	234.74
2	166.67	100	231.36
2.1	166.00	100	227.98
2.2	165.33	100	224.61
2.3	164.67	100	221.23
2.4	164.00	100	217.85
2.5	163.33	100	214.47
2.6	162.67	100	211.09
2.7	162.00	100	207.71
2.8	161.33	100	204.33
2.9	160.67	100	200.95
3	160.00	100	197.58
3.1	159.33	100	194.20
3.2	158.67	100	190.82
3.3	158.00	100	187.44
3.4	157.33	100	184.06
3.5	156.67	100	180.68
3.6	156.00	100	177.30
3.7	155.33	100	173.92
3.8	154.67	100	170.55
3.9	154.00	100	167.17
4	153.33	100	163.79
4.1	152.67	100	160.41
4.2	152.00	100	157.03
4.3	151.33	100	153.65
4.4	150.67	100	150.27
4.5	150.00	100	146.89
4.6	149.33	100	143.52
4.7	148.67	100	140.14
4.8	148.00	100	136.76
4.9	147.33	100	133.38
5	146.67	100	130.00
5.1	146.00	100	131.93

5.2	145.33	100	133.86
5.3	144.67	100	135.79
5.4	144.00	100	137.71
5.5	143.33	100	139.64
5.6	142.67	100	141.57
5.7	142.00	100	143.50
5.8	141.33	100	145.43
5.9	140.67	100	147.36
6	140.00	100	149.29
6.1	139.33	100	151.21
6.2	138.67	100	153.14
6.3	138.00	100	155.07
6.4	137.33	100	157.00
6.5	136.67	100	158.93
6.6	136.00	100	160.86
6.7	135.33	100	162.79
6.8	134.67	100	164.71
6.9	134.00	100	166.64
7	133.33	100	168.57
7.1	132.67	100	170.50
7.2	132.00	100	172.43
7.3	131.33	100	174.36
7.4	130.67	100	176.29
7.5	130.00	100	178.21
7.6	129.33	100	180.14
7.7	128.67	100	182.07
7.8	128.00	100	184.00
7.9	127.33	100	185.93
8	126.67	100	187.86
8.1	126.00	100	189.79
8.2	125.33	100	191.71
8.3	124.67	100	193.64
8.4	124.00	100	195.57
8.5	123.33	100	197.50
8.6	122.67	100	199.43
8.7	122.00	100	201.36
8.8	121.33	100	203.29
8.9	120.67	100	205.21
9	120.00	100	207.14
9.1	119.33	100	209.07
9.2	118.67	100	211.00
9.3	118.00	100	212.93
9.4	117.33	100	214.86
9.5	116.67	100	216.79
9.6	116.00	100	218.71
9.7	115.33	100	220.64
9.8	114.67	100	222.57
9.9	114.00	100	224.50
10	113.33	100	226.43
10.1	112.67	100.9	228.36
10.2	112.00	101.8	230.29
10.3	111.33	102.7	232.21
10.4	110.67	103.6	234.14
10.5	110.00	104.5	236.07
10.6	109.33	105.4	238.00
10.7	108.67	106.3	239.93
10.8	108.00	107.2	241.86
10.9	107.33	108.1	243.79
11	106.67	109	245.71

11.1	106.00	109.9	247.64
11.2	105.33	110.8	249.57
11.3	104.67	111.7	251.50
11.4	104.00	112.6	253.43
11.5	103.33	113.5	255.36
11.6	102.67	114.4	257.29
11.7	102.00	115.3	259.21
11.8	101.33	116.2	261.14
11.9	100.67	117.1	263.07
12	100.00	118	265.00
12.1	100.00	118.9	263.41
12.2	100.00	119.8	261.82
12.3	100.00	120.7	260.23
12.4	100.00	121.6	258.63
12.5	100.00	122.5	257.04
12.6	100.00	123.4	255.45
12.7	100.00	124.3	253.86
12.8	100.00	125.2	252.27
12.9	100.00	126.1	250.68
13	100.00	127	249.08
13.1	100.00	127.9	247.49
13.2	100.00	128.8	245.90
13.3	100.00	129.7	244.31
13.4	100.00	130.6	242.72
13.5	100.00	131.5	241.13
13.6	100.00	132.4	239.53
13.7	100.00	133.3	237.94
13.8	100.00	134.2	236.35
13.9	100.00	135.1	234.76
14	100.00	136	233.17
14.1	100.00	136.9	231.58
14.2	100.00	137.8	229.98
14.3	100.00	138.7	228.39
14.4	100.00	139.6	226.80
14.5	100.00	140.5	225.21
14.6	100.00	141.4	223.62
14.7	100.00	142.3	222.03
14.8	100.00	143.2	220.43
14.9	100.00	144.1	218.84
15	100.00	145	217.25
15.1	108.33	145	215.66
15.2	116.67	145	214.07
15.3	125.00	145	212.48
15.4	133.33	145	210.88
15.5	141.67	145	209.29
15.6	150.00	145	207.70
15.7	158.33	145	206.11
15.8	166.67	145	204.52
15.9	175.00	145	202.93
16	183.33	145	201.33
16.1	191.67	145	199.74
16.2	200.00	145	198.15
16.3	208.33	145	196.56
16.4	216.67	145	194.97
16.5	225.00	145	193.38
16.6	233.33	145	191.78
16.7	241.67	145	190.19
16.8	250.00	145	188.60
16.9	258.33	145	187.01

17	266.67	145	185.42
17.1	275.00	145	183.83
17.2	283.33	145	182.23
17.3	291.67	145	180.64
17.4	300.00	145	179.05
17.5	308.33	145	177.46
17.6	316.67	145	175.87
17.7	325.00	145	174.28
17.8	333.33	145	172.68
17.9	341.67	145	171.09
18	350.00	145	169.50
18.1	350.00	143	170.23
18.2	350.00	141	170.97
18.3	350.00	139	171.70
18.4	350.00	137	172.43
18.5	350.00	135	173.16
18.6	350.00	133	173.90
18.7	350.00	131	174.63
18.8	350.00	129	175.36
18.9	350.00	127	176.09
19	350.00	125	176.83
19.1	350.00	123	177.56
19.2	350.00	121	178.29
19.3	350.00	119	179.02
19.4	350.00	117	179.76
19.5	350.00	115	180.49
19.6	350.00	112.8	181.22
19.7	350.00	112.1	181.95
19.8	350.00	111.4	182.69
19.9	350.00	110.7	183.42
20	350.00	110	184.15
20.1	340.00	109.34	184.88
20.2	330.00	108.68	185.62
20.3	320.00	108.02	186.35
20.4	310.00	107.36	187.08
20.5	300.00	106.7	187.81
20.6	290.00	106.04	188.55
20.7	280.00	105.38	189.28
20.8	270.00	104.72	190.01
20.9	260.00	104.06	190.74
21	250.00	103.4	191.48
21.1	240.00	102.74	192.21
21.2	230.00	102.08	192.94
21.3	220.00	101.42	193.67
21.4	210.00	100.76	194.41
21.5	200.00	100.1	195.14
21.6	190.00	99.44	195.87
21.7	180.00	98.78	196.60
21.8	170.00	98.12	197.34
21.9	160.00	97.46	198.07
22	150.00	96.8	198.80
22.1	140.00	96.14	199.53
22.2	130.00	95.48	200.27
22.3	120.00	94.82	201.00
22.4	110.00	94.16	201.73
22.5	100.00	93.5	202.47
22.6	100.00	92.84	203.20
22.7	100.00	92.18	203.93
22.8	100.00	91.52	204.66

22.9	100.00	90.86	205.40
23	100.00	90.2	206.13
23.1	100.00	89.54	206.86
23.2	100.00	88.88	207.59
23.3	100.00	88.22	208.33
23.4	100.00	87.56	209.06
23.5	115.00	86.9	209.79
23.6	130.00	86.24	210.52
23.7	145.00	85.58	211.26
23.8	160.00	84.92	211.99
23.9	175.00	84.26	212.72
24	190.00	83.6	213.45
24.1	205.00	82.94	214.19
24.2	220.00	82.28	214.92
24.3	235.00	81.62	215.65
24.4	250.00	80.96	216.38
24.5	265.00	80.3	217.12
24.6	280.00	79.64	217.85
24.7	295.00	78.98	218.58
24.8	310.00	78.32	219.31
24.9	325.00	77.66	220.05
25	340.00	77	220.78
25.1	350.00	76	221.51
25.2	350.00	75	222.24
25.3	350.00	74	222.98
25.4	350.00	73	223.71
25.5	350.00	72	224.44
25.6	350.00	71	225.17
25.7	350.00	70	225.91
25.8	350.00	69	226.64
25.9	350.00	68	227.37
26	350.00	67	228.10
26.1	350.00	66	228.84
26.2	350.00	65	229.57
26.3	350.00	64	230.30
26.4	350.00	63	231.03
26.5	350.00	62	231.77
26.6	350.00	61	232.50
26.7	350.00	60	230.31
26.8	350.00	59	228.13
26.9	350.00	58	225.94
27	350.00	57	223.75
27.1	350.00	56	221.56
27.2	350.00	55	219.38
27.3	350.00	54	217.19
27.4	350.00	53	215.00
27.5	350.00	52	212.81
27.6	350.00	51	210.63
27.7	350.00	50	208.44
27.8	350.00	49	206.25
27.9	350.00	48	204.06
28	350.00	47	201.88
28.1	350.00	46	199.69
28.2	350.00	45	197.50
28.3	350.00	44	195.31
28.4	350.00	43	193.13
28.5	350.00	42	190.94
28.6	350.00	41	188.75
28.7	350.00	40	186.56

28.8	350.00	39	184.38
28.9	350.00	38	182.19
29	350.00	37	180.00
29.1	350.00	36	177.81
29.2	350.00	35	175.63
29.3	350.00	34	173.44
29.4	350.00	33	171.25
29.5	350.00	32	169.06
29.6	350.00	31	166.88
29.7	350.00	30	164.69
29.8	350.00	29	162.50
29.9	350.00	28	160.31
30	350.00	27	158.13
30.1	340.00	26	155.94
30.2	330.00	25	153.75
30.3	320.00	24	151.56
30.4	310.00	23	149.38
30.5	300.00	22	147.19
30.6	290.00	21	145.00
30.7	280.00	20	142.81
30.8	270.00	19	140.63
30.9	260.00	18	138.44
31	250.00	17	136.25
31.1	260.00	16	134.06
31.2	270.00	15	131.88
31.3	280.00	14	129.69
31.4	290.00	13	127.50
31.5	300.00	12	125.31
31.6	310.00	11	123.13
31.7	320.00	10	120.94
31.8	330.00	9	118.75
31.9	340.00	8	116.56
32	350.00	7	114.38