

EstSim Pilot Testing: Performance Evaluation of Prototype Simulator

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Aim of pilot testing

- Build on development work by evaluating performance
- Evaluate usability of simulator code

Consideration of:

- Generic versus specific estuaries
- Interpretation of results
- Range of applicability



Pilot testing considerations

Driven by management questions:

- Emergent properties of an estuary
- Sensitivities of an estuary to change
- Constraints on the evolution of the estuary
- Evaluating quantitative model performance



Thames

- Started with generic funnel-shaped estuary
- Initial experiments to validate and produce specific set up
 - Slight change to “marsh” logic statement
 - Addition of encroachment term
- Range of scenarios
 - Barrage, dredging, reclamation, realignment, accelerated sea level rise



Thames Estuary – generic setup

Evolution from start to finish

1	2	3	4	5	6	7	8	9	10	11	12	13	step
1	1	1	1	1	1	1	1	1	1	1	1	1	ocean_waves
1	1	1	1	1	1	1	1	1	1	1	1	1	littoral_sand
1	1	1	1	1	1	1	1	1	1	1	1	1	marine_sand
1	1	1	1	1	1	1	1	1	1	1	1	1	marine_mud
1	1	1	1	1	1	1	1	1	1	1	1	1	macrotidal
0	0	0	1	1	1	1	1	1	1	1	1	1	updrift_beach
1	1	1	1	1	1	1	1	1	1	1	1	1	inlet
0	0	0	0	0	0	0	0	1	1	1	1	1	dunes
1	1	1	1	1	1	1	1	1	1	1	1	1	wind
1	1	1	1	1	1	1	1	1	1	1	1	1	prism
1	1	1	1	1	1	1	0	0	0	0	0	0	accomm_space
0	0	0	1	1	1	1	1	1	1	1	1	1	linear_banks
0	1	1	1	1	1	1	1	1	1	1	1	1	outer_flood_dominance
0	0	0	0	0	0	1	1	1	1	1	1	1	outer_subtidal_sands
0	1	1	1	1	1	1	1	1	1	1	1	1	outer_estuary_swell
0	1	1	1	1	1	1	1	1	1	1	1	1	outer_estuarywaves
0	0	0	1	1	1	1	1	1	1	1	1	1	outer_sandflat
0	1	1	1	1	1	1	1	0	0	0	0	0	inner_flood_dominance
0	0	0	0	0	0	0	0	0	0	1	1	1	inner_ebb_dominance
0	0	0	1	1	1	1	1	1	1	1	1	1	inner_subtidal_deposits
0	0	1	1	0	0	0	0	0	0	0	0	0	inner_estuarywaves
0	0	0	0	0	0	1	1	1	1	1	1	1	inner_sandflat
0	0	0	1	1	1	1	1	1	1	1	1	1	inner_mudflat
0	0	0	0	0	0	0	0	0	0	0	0	1	inner_marsh_low
0	0	0	0	0	0	0	0	0	1	1	1	1	inner_marsh_high
1	1	1	1	1	1	1	1	1	1	1	1	1	river_discharge
1	1	1	1	1	1	1	1	1	1	1	1	1	river_sand
1	1	1	1	1	1	1	1	1	1	1	1	1	river_mud

Set of 28 features present during simulation



Thames Estuary – generic setup

s	f	step
█	█	ocean_waves
█	█	littoral_sand
█	█	marine_sand
█	█	marine_mud
█	█	macrotidal
█	█	updrift_beach
█	█	inlet
█	█	dunes
█	█	wind
█	█	prism
█	█	accomm_space
█	█	linear_banks
█	█	outer_flood_dominance
█	█	outer_subtidal_sands
█	█	outer_estuary_swell
█	█	outer_estuarywaves
█	█	outer_sandflat
█	█	inner_flood_dominance
█	█	inner_ebb_dominance
█	█	inner_subtidal_deposits
█	█	inner_estuarywaves
█	█	inner_sandflat
█	█	inner_mudflat
█	█	inner_marsh_low
█	█	inner_marsh_high
█	█	river_discharge
█	█	river_sand
█	█	river_mud



Show only start and finish steps

Coastal estuary features

Outer estuary features

Inner estuary features



Thames Estuary – specific setup

s	f	step
█	ocean_waves	
█	littoral_sand	
█	marine_sand	
█	marine_mud	
█	macrotidal	
█	updrift_beach	
█	inlet	
█	dunes	
█	wind	
█	prism	
█	accomm_space	
█	linear_banks	
█	outer_flood_dominance	
█	outer_subtidal_sands	
█	outer_estuary_swell	
█	outer_estuarywaves	
█	outer_sandflat	
█	inner_flood_dominance	
█	inner_ebb_dominance	
█	inner_subtidal_deposits	
█	inner_estuarywaves	
█	inner_sandflat	
█	inner_mudflat	
█	inner_marsh_low	
█	inner_marsh_high	
█	river_discharge	
█	river_sand	
█	river_mud	

s	f	step
█	littoral_sand	
█	marine_sand	
█	marine_mud	
█	macrotidal	
█	slr	←
█	inlet	
█	wind	
█	hold_the_line	←
█	prism	
█	accomm_space	
█	linear_banks	
█	outer_flood_dominance	
█	outer_subtidal_sands	
█	outer_estuarywaves	
█	outer_sandflat	
█	outer_mudflat	←
█	inner_flood_dominance	
█	inner_ebb_dominance	
█	inner_subtidal_deposits	
█	inner_estuarywaves	
█	inner_flood_defence	←
█	inner_floodplain	←
█	inner_encroachment	←
█	river_discharge	
█	river_sand	
█	river_mud	

interventions

8 features
out

6 new
features ←



Thames – outer dredging

1	2	3	4	5	6	7	8	step
								littoral_sand
								marine_sand
								marine_mud
								macrotidal
								inlet
								wind
								hold_the_line
								prism
								accomm_space
								linear_banks
								outer_flood_dominance
								outer_subtidal_sands
								outer_estuarywaves
								outer_sandflat
								outer_mudflat
								outer_dredging
								inner_flood_dominance
								inner_ebb_dominance
								inner_subtidal_deposits
								inner_estuarywaves
								inner_flood_defence
								inner_floodplain
								inner_encroachment
								river_discharge
								river_sand
								river_mud

n.b. Accelerated sea level rise = off

Off then on

On then off

Intervention

Off then on

Present version of simulator does not determine significance of change



Range of interventions

Interventions

Seawall	Presence of sea wall
Groynes	Presence of groynes - affects longshore drift
sea level rise	Presence of sea level rise
Hold the line	Management option to maintain current flood defences
Realign	Management option to remove flood defence
Inner flood defence/Outer flood defence	Management option to remove flood
	Defence in the inner/outer estuary
Inner Dredging/Outer dredging	Presence of dredging (deepening) in the inner/outer estuary
Barrage	Presence of a barrage which reduces tidal range in the inlet

- Interventions apply everywhere
 - Can be refined



Thames pilot testing

- Examined reclamation and realignment of inner flood defences
- Realignment
 - Inner flood plain and inner encroachment turned off
 - Inner marsh (high and low) develops
 - Outer estuary not affected



Teign

- Started with generic spit-enclosed estuary
- Initial experiments to validate and produce specific set up
 - An illustrative function for inner reed beds;
 - An updrift seawall; and,
 - No marine mud supply.



Teign

- Reed beds form in the inner estuary as observed
- Absence of marine mud prevents outer-mud-flats from forming
 - In line with observed morphology of the estuary
- But....outer flood dominance
 - estuary is strongly ebb dominant
- Definition of estuary (inner and outer)
 - No obvious “inner” and “outer” sections
 - Outer estuary is only a very short section between the narrow mouth and Shaldon Bridge about 1km up-estuary
 - A matter of interpretation



Scenarios tested

- Flood defences
- Realignment
- Dredging
- Groynes (on coast)



Simulation of outer dredging

1	2	3	4	5	Step
[Blue shaded area]					ocean_waves
					longshore_power
					littoral_sand
					marine_sand
					Mesotidal
					updrift_beach
					Spit
					Inlet
					downdrift_beach
					Dunes
					Wind
					Seawall
					Prism
					accomm_space
					ebb_delta
flood_delta					
outer_flood_dominance					
outer_subtidal_sands					
outer_estuarywaves					
outer_sandflat					
outer_dredging					
inner_ebb_dominance					
inner_subtidal_deposits					
inner_sandflat					
inner_mudflat					
inner_marsh_low					
inner_marsh_high					
inner_reed_bed					
river_discharge					
river_sand					
river_mud					

} increased
 accommodation
 space

 } loss of ebb and
 flood deltas

 } loss of outer
 subtidal sands

 } inner estuary
 unaffected



Interpretation of dredging

- Definition of inner and outer estuary
 - Complicates the interpretation
- Dredging in inner estuary
 - No affect on outer estuary, down drift beach, accommodation space and flood and ebb deltas
- Inner subtidal deposits are removed
 - Inner mud flats, marshes and reed beds remain
 - Lack of sensitivity to scale of intervention



EstSim simulator - Conclusions (1)

- Easy to use and quick to run
- Can be used readily to explore generic estuary behaviour
- Can be set up for specific estuaries
 - Requires good knowledge of estuary geomorphology and processes
 - Requires initial testing with “data” on estuary
- Can be used to evaluate general direction of change



EstSim simulator - Conclusions (2)

- In present form cannot capture scale of change
 - E.g. large vs minor
- Partial ability to capture sensitivities
- Can be used to help develop conceptual models and as an educational tool
- Interpretation is key (i.e. “on”/”off”) and context important

