University of Southampton

SOES6011 Assignment 2

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1 February 2024

Assignment

Your second assignment will focus on Southampton Water, UK. You will assess the morphological impact of a dredge of the main channel in 2020 and a reclamation of an area of the River Test tidal flats in 2030. This will require you to assess how sediment import/export has changed and what impact this has had on the morphology of Southampton Water and the River Test.

Examine the likely impact of a dredge and a reclamation in Southampton Water

- To explore the morphological dynamics of the estuary and the impacts of the proposed changes:
- Set-up a 4-element Asmita model of Southampton Water using the data provided in 'SW4e model parameters.xls'. Set start year to 1800 and run the model for 300 years.
- Construct a base case comprising the historic changes and sea level rise of 2mm/year.
- Examine the influence of an 18.6 year lunar nodal cycle with an amplitude of 0.15m.
- Examine the effect of historical interventions due to dredging and reclamation
- Introduce a dredged channel 200m wide and 2m deeper than existing bed in 2020 and a reclamation on the R. Test tidal flat element removing 20ha and reducing tidal prism by 0.5Mm3 in 2030.

[Note: the focus of the assignment is the examination of morphological change due to interventions, and not the application of the Asmita model, which is just the tool to be used to examine the changes].

Cases to be considered

Construct a model using the parameters provided, including the historic changes and river input.

Then examine the following scenarios:

1. With sea level rise of 2mm/year with no interventions
2. As case 1 with sea level rise of 2mm/year, and a nodal cycle of amplitude 0.15m.
3. As case 1, but now with the historic changes included.
4. As case 3, with the introduction of a dredged channel in the year 2020. The channel is to be 200m wide and 2m deeper than existing bed, along the full length of the channel.
5. As case 4, with the introduction of a reclamation on the R. Test tidal flat element in the year 2030. The reclamation occupies 20ha of the tidal flat and reduce the tidal prism by 0.5Mm3.

What are the changes in volume of the estuary over the period 1900 to 2100?

a) Morphological changes (fixed surface); and

b) Combined morphological and water level changes (moving surface).

Considering the historical changes and the proposed developments (cases 4 and 5), which has the biggest impact and why? How do the changes compare with historic interventions?

Supporting materials

Unzip the file ASMITA_assignment.zip to your working folder. The zip file should contain:

- ASMITA exercise instructions.pdf – explanation of the exercise
- ASMITA Soton assignment.pdf – a pdf copy of these slides
- Note on Southampton Water.pdf –a background description of the estuary.
- SW4e model parameters.xlsx – spreadsheet with summary of element properties and historic changes.
- SW4e element properties.txt – text file of the element properties to be loaded.
- Inner Channel Interventions.txt – text file of the historic interventions.

Preliminary steps

- Read the Note on Southampton Water.
- Try to understand the main influences on the estuary
- Develop your own conceptual model of how you think the system works.
- Think about how you might represent your conceptual model to study long-term change using ASMITA.
- Look at the other resources provided to understand the data available:
  - SW4e model parameters.xlsx;
  - SW4e element properties.txt;
  - Inner Channel Interventions.txt
- Do you think there is any other data needed?
- Make a plan to undertake the assignment

Southampton Water

Setting

Elevation map source: ABP 2000

Meso-tidal spit enclosed estuary, draining a catchment of about 1,500 km^2

Mouth to the tidal limit is about 17km.

Estuary flanked by land, which rises rapidly to over +10 m ODN.

Only limited scope for lateral roll back (landward movement) of the intertidal, in response to sea level rise.

Northeast shore

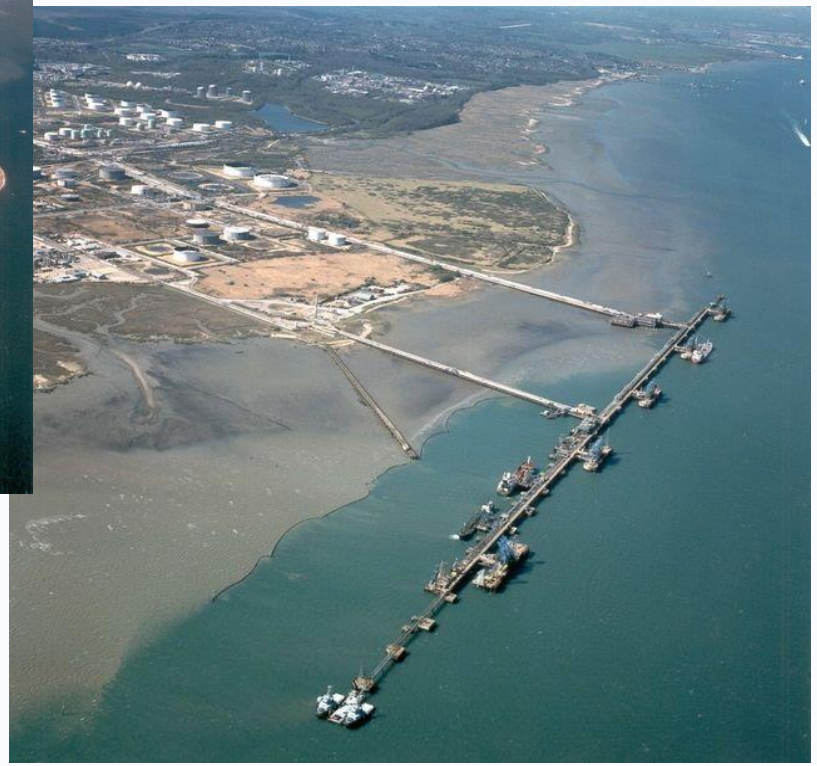
Natural beach at Netley

Wall (sheet pile) between Weston and Hamble Point

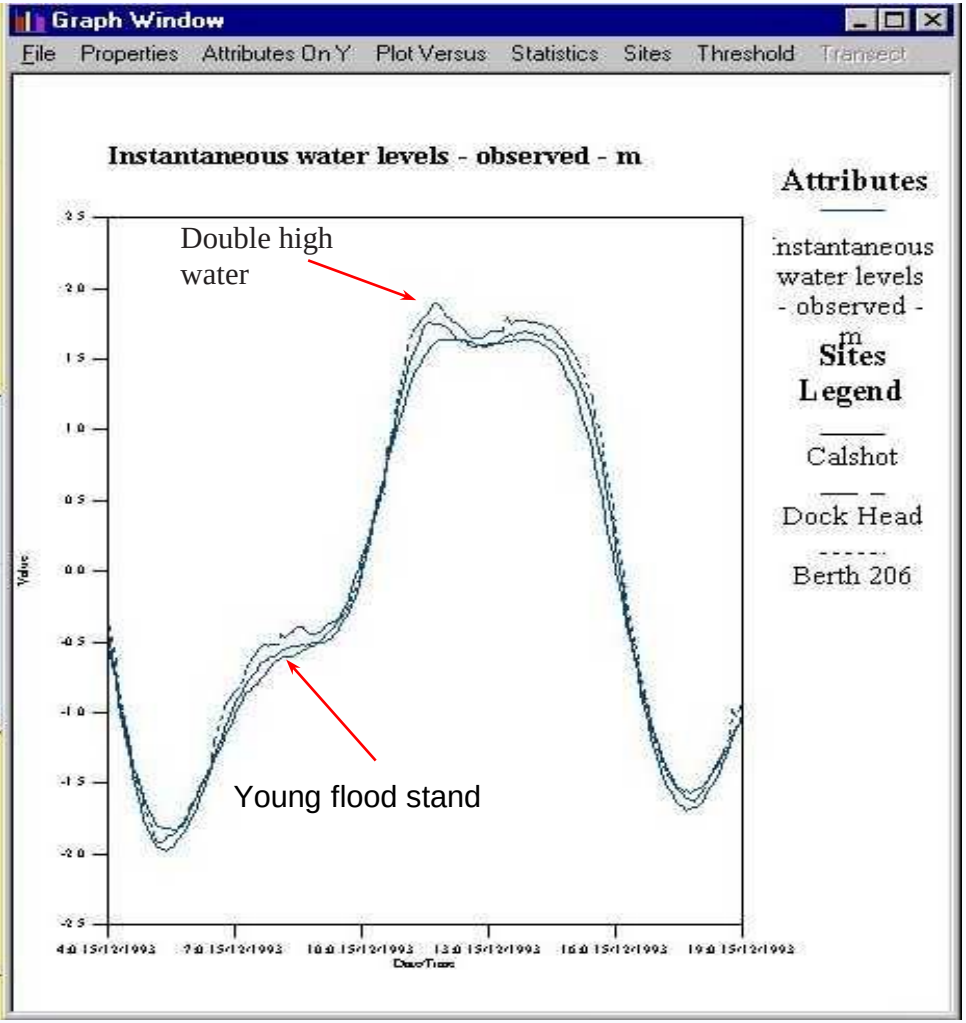
Southwest shore

Calshot Spit with Fawley power station to the rear

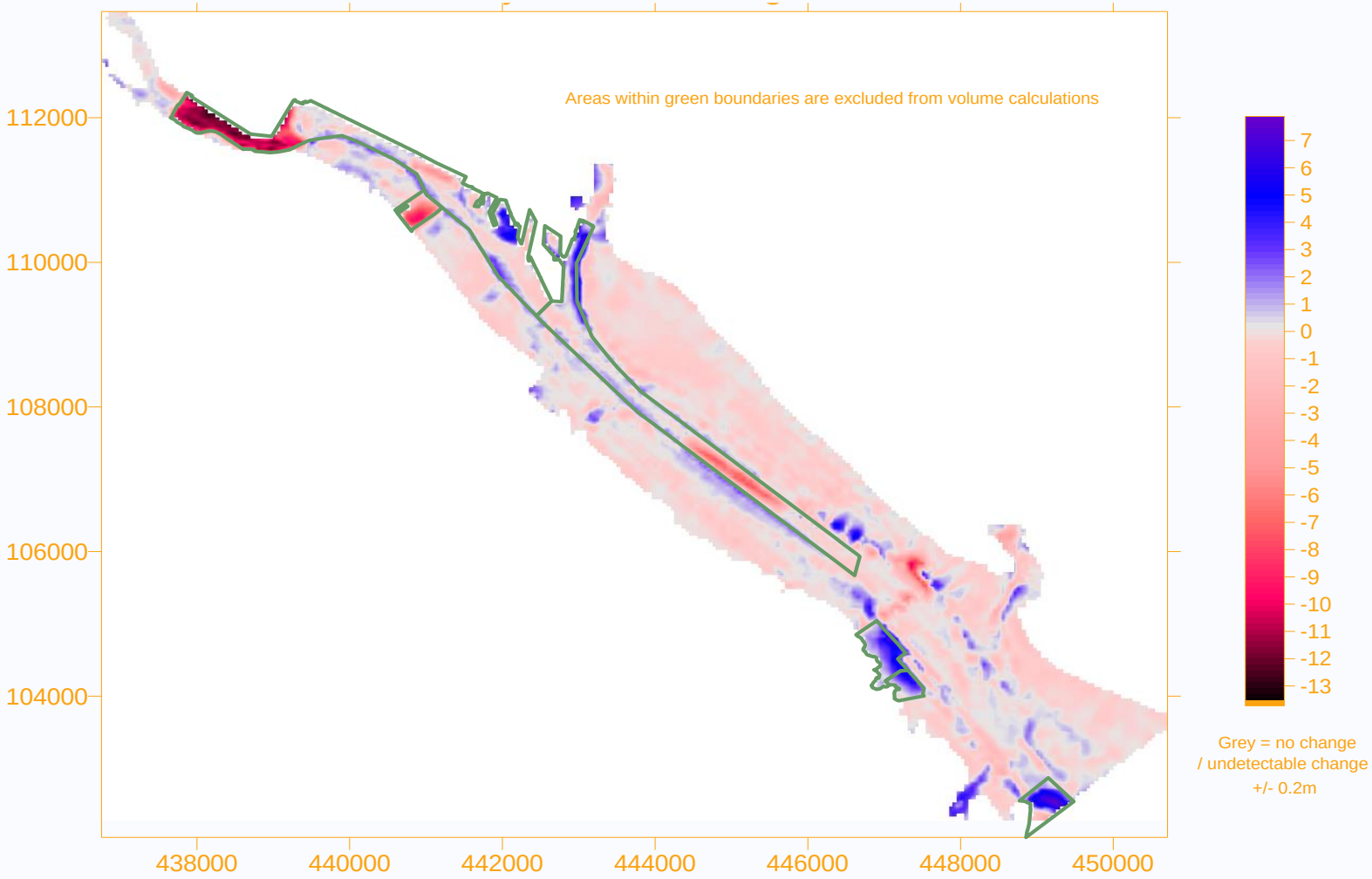
Fawley terminal with Hythe marshes in the background



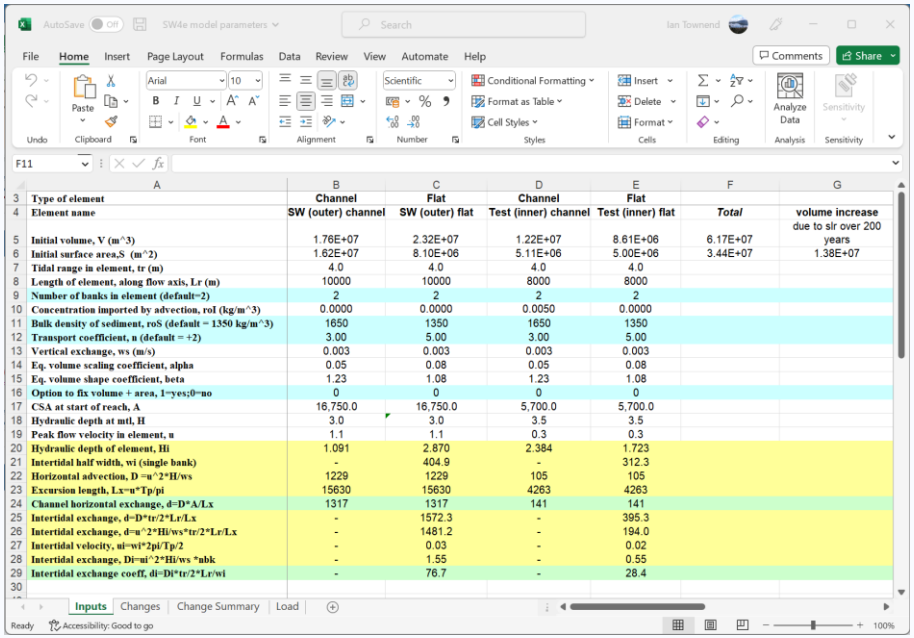
Tidal Water Levels



Historical change analysis

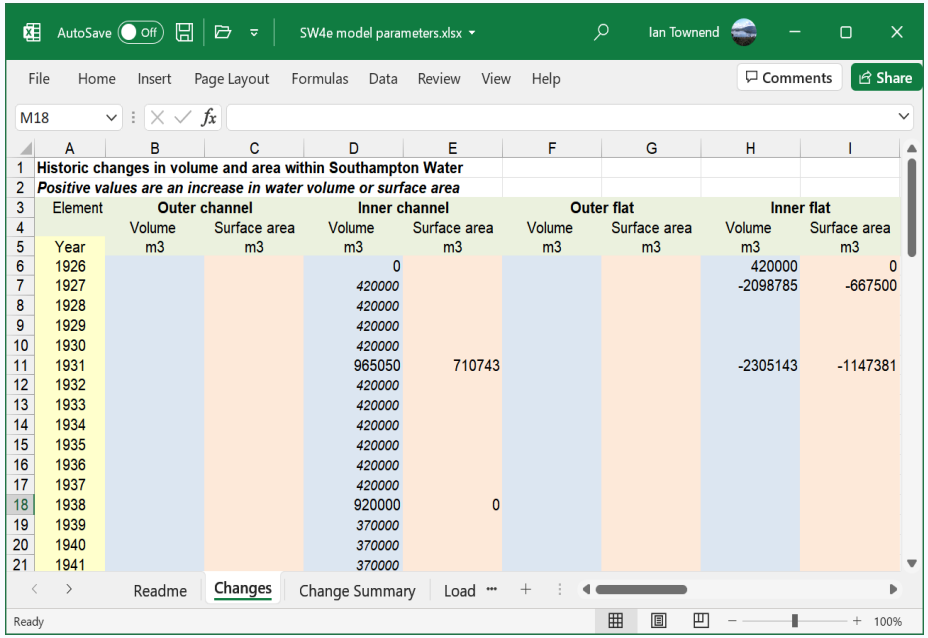


Source data
in file: SW4e model parameters.xlsx



Type of element	Channel	Flat	Channel	Flat		
Element name	SW (outer) channel	SW (outer) flat	Test (inner) channel	Test (inner) flat	*Total*	volume increase due to slr over 200 years
Initial volume, V (m^3)	1.76E+07	2.32E+07	1.22E+07	8.61E+06	6.17E+07	
Initial surface area,S (m^2)	1.62E+07	8.10E+06	5.11E+06	5.00E+06	3.44E+07	1.38E+07
Tidal range in element, tr (m)	4.0	4.0	4.0	4.0		
Length of element, along flow axis, Lr (m)	10000	10000	8000	8000		
Number of banks in element (default=2)	2	2	2	2		
Concentration imported by advection, roI (kg/m^3)	0.0000	0.0000	0.0050	0.0000		
Bulk density of sediment, roS (default = 1350 kg/m^3)	1650	1350	1650	1350		
Transport coefficient, n (default = +2)	3.00	5.00	3.00	5.00		
Vertical exchange, ws (m/s)	0.003	0.003	0.003	0.003		
Eq. volume scaling coefficient, alpha	0.05	0.08	0.05	0.08		
Eq. volume shape coefficient, beta	1.23	1.08	1.23	1.08		
Option to fix volume + area, 1=yes;0=no	0	0	0	0		
CSA at start of reach, A	16,750.0	16,750.0	5,700.0	5,700.0		
Hydraulic depth at mtl, H	3.0	3.0	3.5	3.5		
Peak flow velocity in element, u	1.1	1.1	0.3	0.3		
Hydraulic depth of element, Hi	1.091	2.870	2.384	1.723		
Intertidal half width, wi (single bank)	-	404.9	-	312.3		
Horizontal advection, D =u^2*H/ws	1229	1229	105	105		
Excursion length, Lx=u*Tp/pi	15630	15630	4263	4263		
Channel horizontal exchange, d=D*A/Lx	1317	1317	141	141		
Intertidal exchange, d=D*tr/2*Lr/Lx	-	1572.3	-	395.3		
Intertidal exchange, d=u^2*Hi/ws*tr/2*Lr/Lx	-	1481.2	-	194.0		
Intertidal velocity, ui=wi*2pi/Tp/2	-	0.03	-	0.02		
Intertidal exchange, Di=ui^2*Hi/ws *nbk	-	1.55	-	0.55		
Intertidal exchange coeff, di=Di*tr/2*Lr/wi	-	76.7	-	28.4		

Model parameters



Historic changes in volume and area within Southampton Water

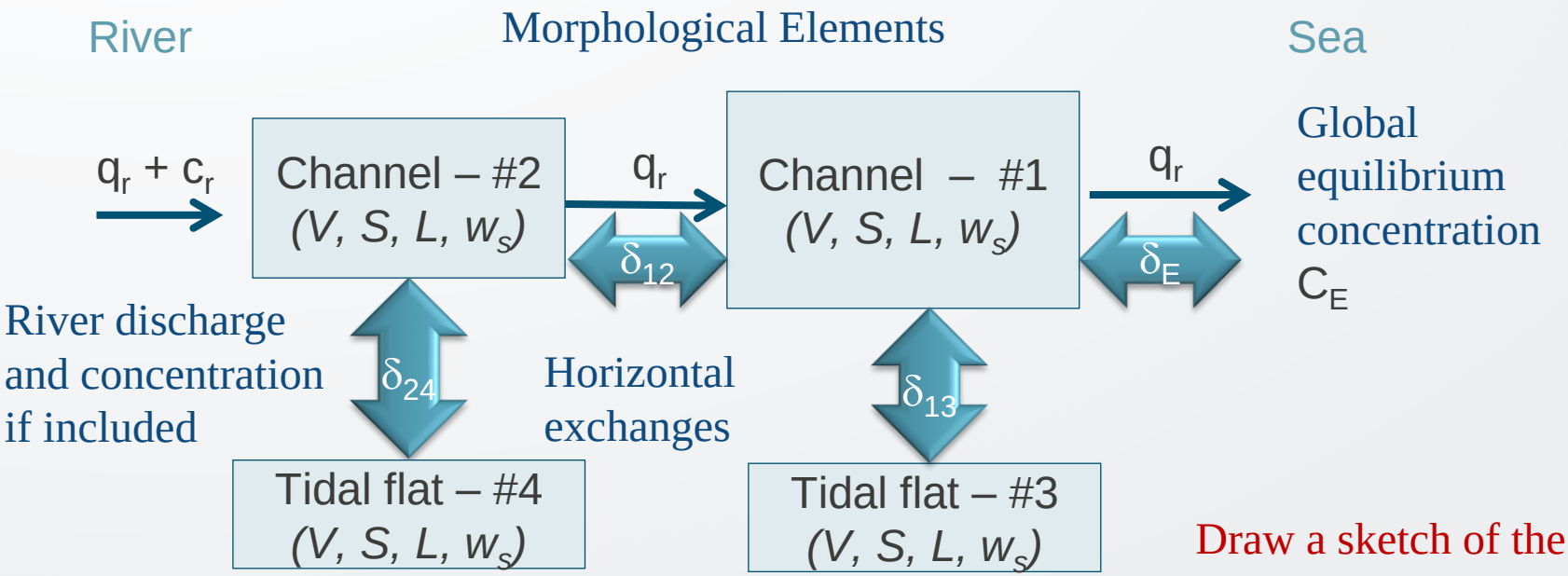
Positive values are an increase in water volume or surface area

Element	Outer channel		Inner channel		Outer flat		Inner flat	
	Volume	Surface area	Volume	Surface area	Volume	Surface area	Volume	Surface area
Year	m3	m3	m3	m3	m3	m3	m3	m3
1926			0				420000	0
1927			*420000*				-2098785	-667500
1928			*420000*					
1929			*420000*					
1930			*420000*					
1931			965050	710743			-2305143	-1147381
1932			*420000*					
1933			*420000*					
1934			*420000*					
1935			*420000*					
1936			*420000*					
1937			*420000*					
1938			920000	0				
1939			*370000*					
1940			*370000*					
1941			*370000*					

Interventions

NB: the file Inner Channel Interventions.txt can be used to load the interventions in the inner channel. Interventions in other elements need to be added manually using the UI.

Sketch the model layout and exchanges



V – Volume
S – Plan area
L – Length
w_s – vertical exchange

Draw a sketch of the exchanges between the elements using the values provided in 'SW4e model parameters.xlsx'

Typical Workflow to Setup Asmita

A typical workflow is to define the Estuary properties and the Elements, including dispersion and water levels. Additions, such as interventions and rivers, are added after Elements have been defined.

The workflow using the **Setup** menu is typically:

- **Estuary>System Parameters**: define the equilibrium density and check that other parameters that are not needed have default value or are set to 0.
- **Estuary>Water Levels**: define tidal amplitude, rate of sea level rise and nodal cycle (if required).
- **Elements>Define Elements**: define the types of element to be included in the model and give each element a name.
- **Elements>Element Parameters**: define the element parameters for each element (volume, plan area, etc), *OR* **Elements>Load Parameters** to load the parameters for all elements from a file.
- **Estuary>Dispersion**: define the horizontal exchange matrix based on the tidal propagation.
- **Run Parameters>Time Step**: define time step, run duration and start year.
- **Run Parameters>Conditions**: set any conditions to be applied to the model run (e.g.. scale to initial values. Only include other options if they have been defined).
- **Run Parameters>Select Eq. Coefficients**: Select the equilibrium coefficients that define the equilibrium volume for each element type (use Default for this assignment).

This should be sufficient for the model to run, as long as interventions and river advection are excluded in the **Run Parameters>Conditions**.

Workflow to add river advection and interventions

To add a river advection:

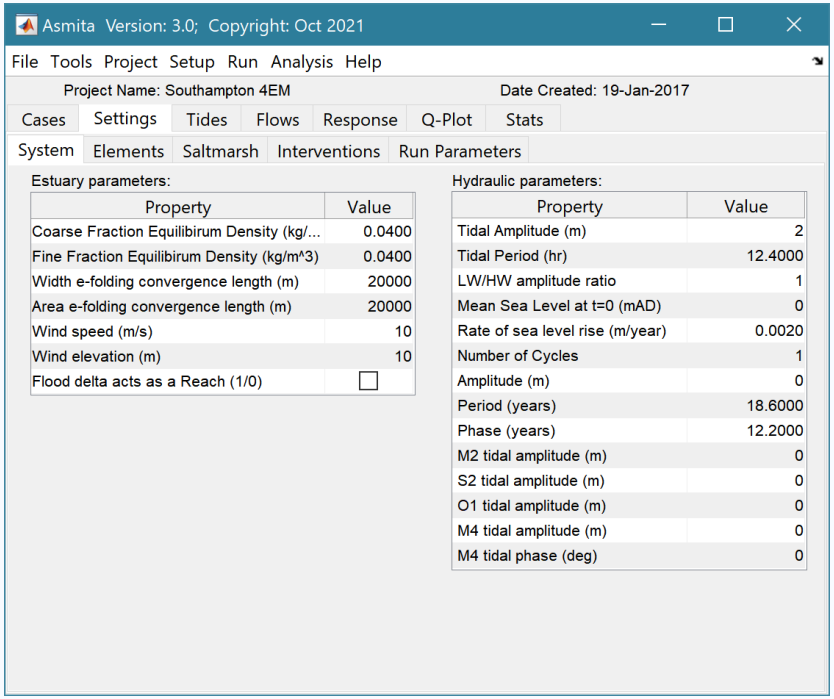
- **Rivers>River Inputs**: define the model element that the river flows into, the flow rate and the sediment load.
- **Rivers>River Advection**: define the advection matrix (Note: this must result in a mass balance in the flow in and out of each element, ultimately to the sea).
- **Run Parameters>Conditions**: modify the conditions to include the river flow in the run and whether or not to include the river flow in the initial equilibrium, or treat the river flow as a perturbation to the initial condition.

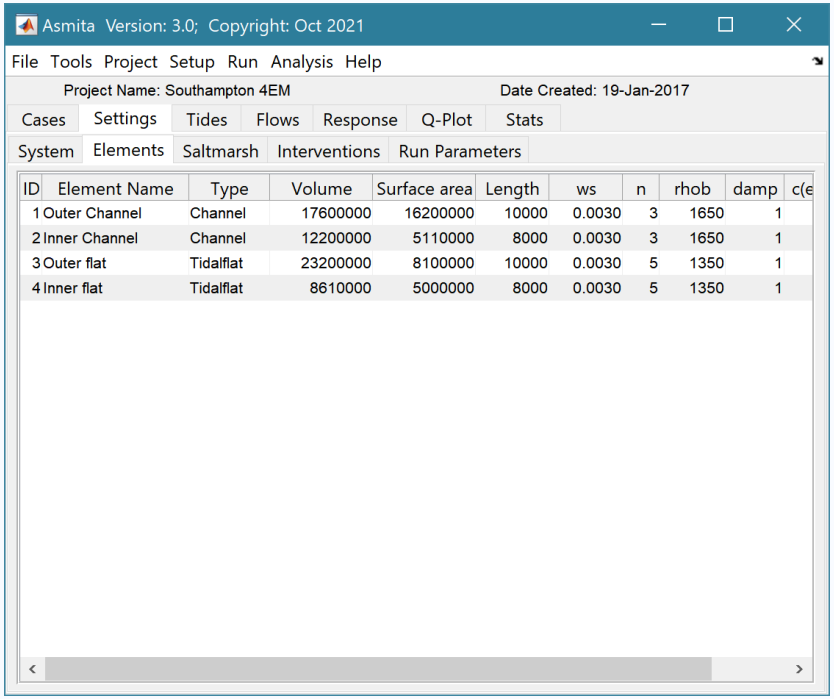
To add interventions:

- **Interventions>Add or Edit**: select the element to apply intervention(s) to. Changes to the volume and/or plan area can be defined for any number of years. Repeat for other elements as required.
- **Interventions>Load File**: the interventions to be applied to a specific element can be defined in a text file and then loaded using this option (useful alternative to the manual option if there are a lot of modifications to be included).
- **Run Parameters>Conditions**: modify the conditions to include the interventions in the model run.

Set-up the model (1) – Schematisation

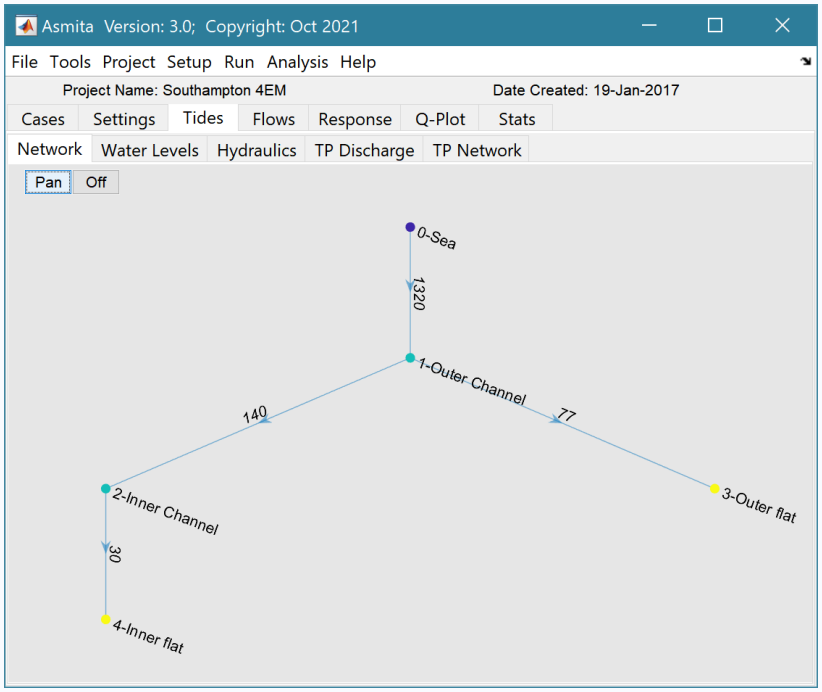
Estuary parameters, Element parameters, and Water Levels

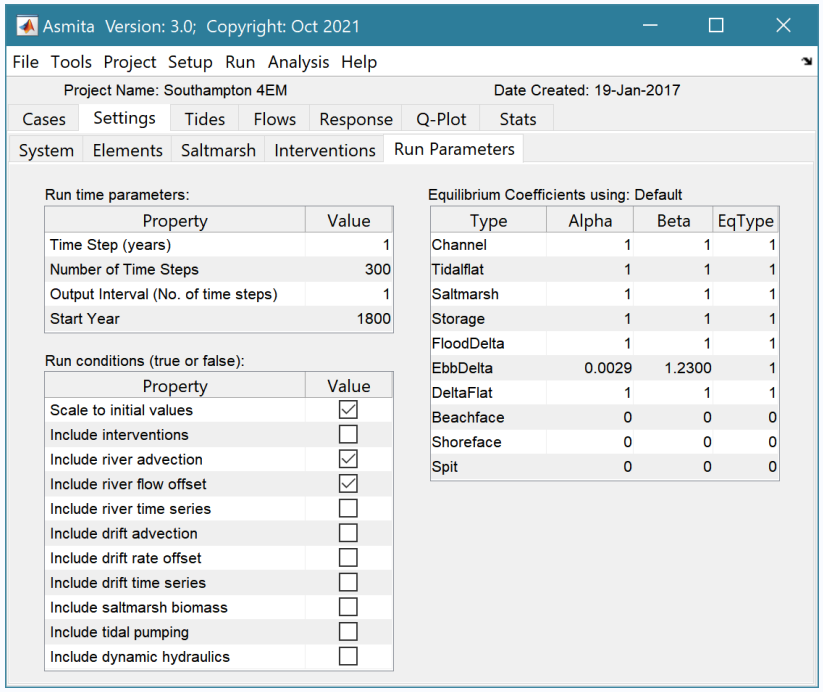




Set-up the model (2) – Network and settings

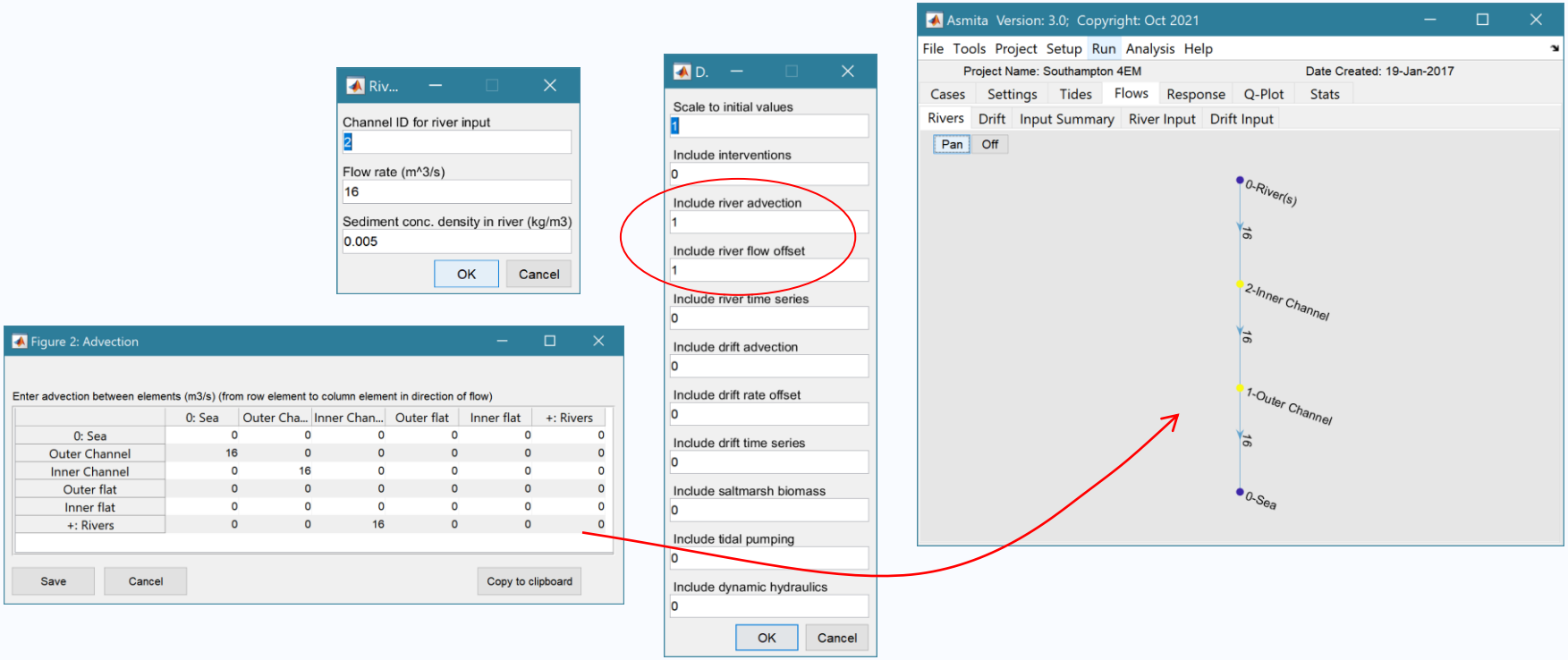
Horizontal tidal exchange (Dispersion), Run Timestep, Run Conditions and Equilibrium Coefficients





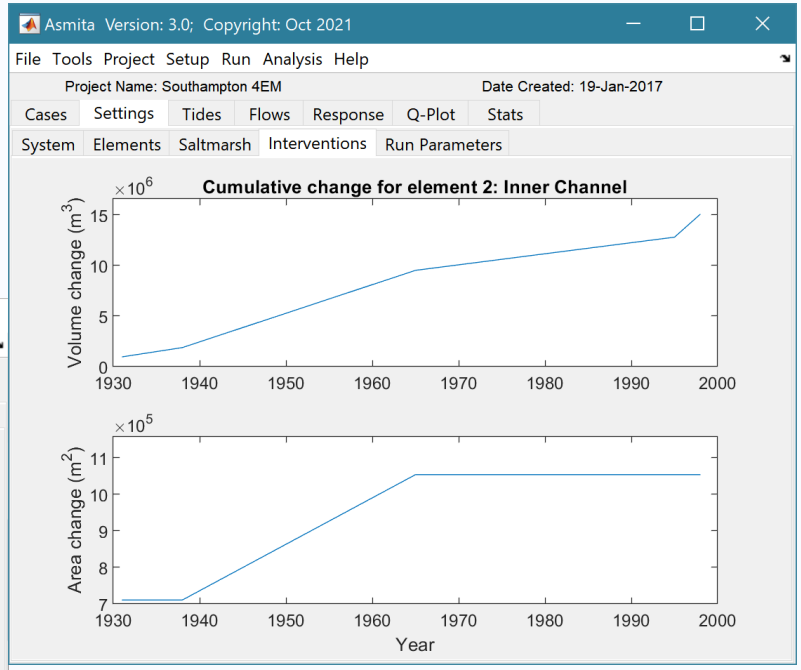
Set-up the model (3) – Advection flows

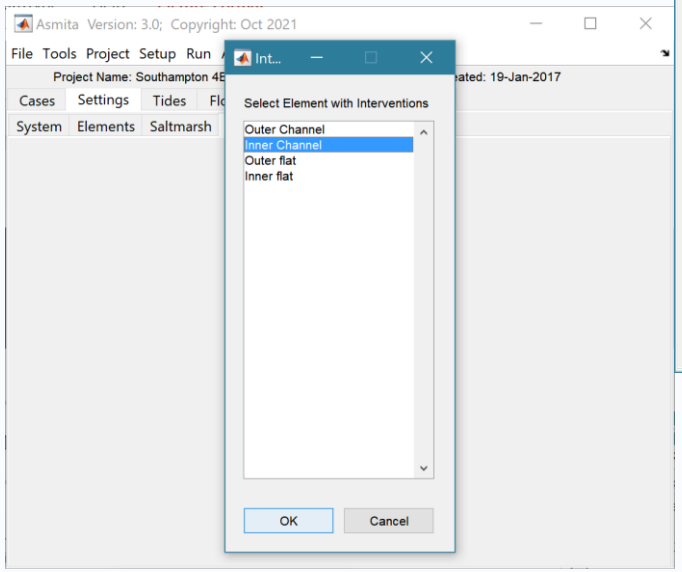
River input, sediment load, advection flow through system and run conditions



Add in the interventions

Setup>Interventions>Add
to enter changes for specific years
or
Setup>Interventions>Load
to load from a file (e.g. if there are a lot of changes such as annual maintenance dredging)





Cases to be considered

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Then examine the following scenarios:

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b) Combined morphological and water level changes (moving surface).

Considering the historical changes and the proposed developments (cases 4 and 5), which has the biggest impact and why? How do the changes compare with historic interventions?

Final Report

We would like you to write a concise report describing your analysis in no more than 2,000 words (excluding table of contents, references, figure captions and tables).
The report should contain the following section headings:

1. **Abstract**
2. **Introduction** – motivation of the study, ideally setting the scene in a broader context; background to Southampton Water, the aim of the study, and an outline of the structure of the report.
3. **Methods** – a brief description of the methods you employed and the cases examined.
4. **Results** – a description of the key findings that best help you to explain what you found and can be used to support point made in the discussion.
5. **Discussion** –discuss which of the scenarios has the biggest impact and why; and how the new changes compare with the historical changes. This should endeavour to relate the findings to the relevant literature. Some consideration of the assumptions of the ASMITA model, what other modelling approaches could be used, and how these are likely to compare with the approach adopted (strengths and weaknesses) should also be included.
6. **Conclusion** – a summary of your key findings.
7. **References**.

You may use a total of 4 figures – no more!

Deadline for submission is 2pm Wednesday 22nd May 2024.