**MorphEst: An automated toolbox for measuring estuarine planform geometry from remotely sensed imagery and its application to the South Korean coast**

Nathalie W. Jung1, Guan-hong Lee1\*, Yoonho Jung1, Steven M. Figueroa1, Kenneth D. Lagamayo1, Tae-Chang Jo2 and Jongwi Chang1

1Inha University, Department of Oceanography, 100 Inharo, Incheon, 22212, Republic of Korea

2Inha University, Department of Mathematics, 100 Inharo, Incheon, 22212, Republic of Korea

\*Correspondence author: [ghlee@inha.ac.kr](mailto:ghlee@inha.ac.kr)

**MORPHEST EXAMPLE**

This Readme explains all tools included in MorphEst. Further details are found in the accompanying paper (IN REVIEW). Examples of channel masks are provided for Mangyeong River in 1985 and 2015.

This document is supposed to be used as a reference for the *MorphEst\_Example.m* code. There is no GUI, and the demo is meant to be executed from the MATLAB editor. The code is divided into individual sections (%%) that can be run by clicking “Ctrl+Enter” and “Run Section”. Numbers in this document correspond to numbers in the *MorphEst\_Example.m* code.

1. **LOAD DATA**

Three to four inputs are required by MorphEst:

1. **Channel mask:** One or two text files that include the coordinates (in meters) of the lower-left corner of the channel mask raster extent as well as the overall areal extent of the channel mask at time 1 and time 2 in binary code. Water pixels should have a value of 1 and nonwatery pixels should have a value of 0. Two text files are required (i.e., same estuary at two time steps), if area change calculations are desired. Only one text file is required (i.e., one estuary at one time step), if only shape calculations are desired.

Example files **kor\_15\_r85** include information about Mangyeong River, South Korea, in 1985. Channel masks were created based on the Global Surface Water Dataset (Pekel et al., 2016). MorphEst does not include an explanation on how to create a channel mask.

1. **Estuary mouth:** Two text files include the coordinates (one text file in meters and one text file in decimal degrees) and width (in meters) of the estuary mouth.

Example files **KOR\_15\_coords1** includes the mouth x and y coordinates of Mangyeong River in meters as well as the width at the mouth in meters (14100312.67730, 4547551.73300, 2028.00000), **KOR\_15\_proj\_coords** includes the mouth x and y coordinates of Mangyeong River in decimal degrees as well as width at the mouth in meters (126.66526, 37.77402, 2028.00000).

****

First, the user should change the input the directory of the two estuary mouth text files and the 1985 channel mask file (D:). We recommend adding all text files to the same directory. Before running this cell, the user should also make sure to save the folder path of his directory. To do so, click “Home” > “Environment” > “Set Path”.

The code is written so that it will import all channel masks with the ending “\_r85.txt” and all estuary mouth files with the ending “\_coords1.txt” and “proj\_coords.txt”. This allows the user to import and process channel masks and estuary mouth files for several estuaries at the same time.

* 1. **CREATING CHANNEL CENTERLINE**

This cell includes MorphEst’s *centerline\_from\_mask\_MorphEst* function (modified from RivMAP’s *centerline\_from\_mask* function). After running this cell, the user should see the output EST\_C1, which contains information about the estuary’s mouth coordinate in meters (start\_x and start\_y), decimal degrees (start\_x\_coor and start\_y\_coor) as well as the row and column within the channel raster (point\_x and point\_y). It further includes the cell size (cell), width of the estuary mouth (M\_width), the number of columns and rows of the channel raster (col, row), buffer radius for later shape calculations (rad), the cardinal direction of the estuary mouth within the channel raster (S\_dir), the cardinal directions of the start and end points (dir), the channel data in binary code (data), the x and y points of the centerline (cl), the centerline location in binary code (lcl), the location of the centerline starting from the estuary mouth (instead of the raster edge/channel mask intersection) (Rind), and the distance of each centerline point from the estuary mouth point (Length).

The channel mask, the location of the estuary mouth point (cyan circle), and centerline (red line) can be displayed by running the cell %% Plot channel mask and centerline. The centerline starts from the intersection between the raster edge and the channel mask, but calculations are starting from the estuary mouth point (Rind).



* 1. **CHANNEL BANKS**

The next cell uses the *banklines\_from\_mask\_MorphEst* function to create channel bank lines based on the output from the *centerline\_from\_mask\_MorphEst* function. The new outputs include the coordinates of the bank lines (bank).

The channel mask, the location of the estuary mouth point (cyan circle), and bank lines (blue lines) can be displayed by running the cell %% Plot channel mask and bank lines.



* 1. **CHANNEL WIDTH**

The next cell uses the *width\_from\_mask\_MorphEst* function to calculate along-channel width based on the outputs from the *banklines\_from\_mask\_MorphEst* function. The new outputs contain along-channel width information (Wbl).

* 1. **ESTUARINE SHAPE**

The next cell uses the *Est\_Shape* function to estimate estuarine shape based on the outputs from the *width\_from\_mask\_MorphEst* function. The new outputs include the width at the estuary mouth interpolated from the nonlinear least-square fit based on the width/length profile (f\_W), convergence length (f\_L), goodness of the fit estimates (f\_rsquare and f\_lambda), and estuarine shape (S). A small shape value indicates a funnel shape and a large shape value indicates a straight channel.

Running the next cell will plot the along-channel width/length profile including the nonlinear least square fit based on which estuarine shape was calculated.



1. **SHAPE FOR 2015**

The previous steps showed how to estimate estuarine shape for Mangyeong River in 1985. The same steps can be repeated in section 2.1 – 2.4. to estimate estuarine for Mangyeong River in 2015. Here, the user should change the directory (D:) in section 2. Define input directories for 2015.





1. **ESTUARINE AREA CHANGE**
   1. **CALCULATE ESTUARINE LENGTH**

The next section uses the *Est\_Length* tool to calculate estuarine length. Estuarine shape estimates only required the input of one channel mask (i.e., one estuary at one time step). The following functions require two channel masks (i.e., one estuary at two time steps) in order to estimate areal change. **Before running this section, the centerline function should be run for both time steps.** Running this section will create an output that contains information about the measured estuarine length at time 1 (EST\_SL1) and time 2 (EST\_SL2) in raster format and at both time steps in text format (EST\_L).

***Note: This function requires the input of a bathymetry dataset and M2 tidal amplitude dataset.*** *This code provides links to available global dataset, but the user is free to exchange these for local datasets with a higher resolution.*

***Global bathymetry dataset****:* <https://topex.ucsd.edu/WWW_html/srtm15_plus.html>

***Global m2 tidal amplitude dataset****:* <http://www.legos.obs-mip.fr/en/share/soa/cgi/getarc/v0.0a/index.pl.cgi?contexte=SOA&donnees=maree&produit=modele_fes>

* 1. **CALCULATE AREAL CHANGE BETWEEN TWO TIME STEPS**

The next section uses the *Est\_AreaChange* function to estimate areal change between two time steps based on the output of the *Est\_Length* function. Running this section will create an output that contains information about the measured area change at time 1 (EST\_SA1) and time 2 (EST\_SA2) in raster format and at both time steps in text format (EST\_A). **This section can also be applied for river channels.** If river channels have different dimensions, this function will simply adjust the upstream extent of the longer channel mask to the shorter channel mask.

Running the next section shows area gain (green), area loss (red) and no change (white).

****

* 1. **CALCULATE CAUSE OF ESTUARINE SURFACE AREA LOSS**

The next section uses the *Est\_AreaChange\_Land* function to estimate areal change between two time steps based on the output of the *Est\_AreaChange* function. Running this section will create an output that contains information about the measured land use (EST\_A). **This section can also be applied for river channels.**

***Note: This function requires the input of a land use dataset.*** *This code provides links to available global dataset, but the user is free to exchange these for local datasets with a higher resolution.*

***Global Land use dataset:***<http://maps.elie.ucl.ac.be/CCI/viewer/download.php>