

A Tool for Rapid Configuration of A River Model

Cheryl Ann Blain*, Robert S. Linzell†, Alan D. Weidemann‡ and Paul E. Lyon‡

*Oceanography Division, Code 7322

Naval Research Laboratory, Stennis Space Center, MS 39529

Email: blain@nrlssc.navy.mil, Telephone: (228) 688-5450, Fax: (228) 688-4759

†QuinetiQ North America, Technology Solutions Group

Stennis Space Center, MS 39529

‡Oceanography Division, Code 7334

Naval Research Laboratory, Stennis Space Center, MS 39529

Abstract—A tool has been developed, the River Simulation Tool (RST), that allows the configuration of a two-dimensional hydrodynamic river model based on imagery-extracted information that defines model geometry and water depth, as available. The RST contains automated shoreline processing and mesh generation capabilities for unstructured grids and accommodates user-specified forcing and parameter values. Alternatively, the RST provides synthetic bathymetry and default forcing and parameter values for those situations in which observational data or information describing the river environment is unavailable. This manuscript describes the components of the RST in detail and its application to the upper East Pearl River, MS. Solutions for water level and currents from the RST-generated river model are compared to a “truth” solution for the same region. Implementation of the RST’s ensemble creation feature allows an assessment of the sensitivity of river predictions to the specification of water depth, bottom type, and upstream discharge conditions.

I. INTRODUCTION

Rivers pose one of the most challenging environments to characterize as they form the interface between land and water in the coastal margin. Rivers are geometrically complex and are continually changing in position and character. Predictive models of the river environment require detailed descriptions of the river bank position, bed elevation, upstream fluxes and downstream variability due to tidal modulations. To compound the difficulty, Navy river operations are most often conducted in denied areas across the globe where very little of this information is available.

To address the need for a predictive capability for currents and water level in rivers in regions where knowledge of the system is limited, an approach is devised that initiates a river model from available imagery and provides contingencies for missing data. Presented are the details of a River Simulation Tool (RST) Graphical User Interface (GUI) whose capabilities include the 1) extraction and processing of river bank coordinates from imagery, 2) generation of an unstructured mesh of the river using river bank positions and available or synthetic bathymetry, 3) application of upstream and downstream boundary forcing data, 4) contingencies for handling missing data, and 5) an interface to configure multiple realizations of the developed river model.

The River Simulation Tool (RST) is the developed interface that implements the above described capability. Herein, a

description of the RST features and present limitations are detailed. The paper follows with a demonstration of the RST applied to a portion of the East Pearl River, MS. Performance of the RST is compared to a validated model of the Pearl River System [1] and, from this comparison, sensitivity of the predicted currents and water levels to the choices of parameter specifications and model forcing are examined.

II. THE RIVER SIMULATION TOOL (RST)

The RST is comprised of MATLAB-based software that provides an intuitive interface for configuring a 2D hydrodynamic model of a river or river segment that has been remotely observed and recorded in imagery data. To achieve full functionality, the RST GUI utilizes additional software tools, written in other computer programming languages such as FORTRAN and Perl. The RST is designed to be flexible and yet self-contained. The capability for interactive editing of the river shoreline or the computational mesh to specified model parameters and forcing is an integral feature of the software. At the same time the RST maintains default configurations for the model and contingencies to specify missing information, as necessary, such as upstream forcing or bathymetry. Realizing that a great deal of uncertainty can accompany application of the RST to a real river, a capability for configuring multiple input specifications is available. From these multiple data sets an ensemble of model runs can be performed that bracket the uncertainty or assess the sensitivity of predictions to unknown inputs. Execution of the river model is performed external to the RST software package as the domain size and model execution time can become sufficiently great to require workstation cluster, or even supercomputer, resources.

At present the RST targets the finite element-based hydrodynamic simulator ADCIRC, the Advanced Circulation Model for Shelves, Coastal Seas, and Estuaries [2]. As such the RST produces model files in formats that directly interface with the ADCIRC model [3]. The grid generation process produces unstructured meshes composed of linear triangles and the specification of forcing and parameter values are also consistent with the ADCIRC model. Future work could address the creation of interfaces for other hydrodynamic models.

A. Components and Features

The RST is comprised of six components defined by their functional goal and a visual display field that facilitates interaction and understanding within the RST. Components on the initial page of the GUI, shown in Fig. 1, are identified from top to bottom on the left side of the GUI as: *Mesh Creation* which encompasses shoreline creation, bathymetry specification and automated grid generation, *Model Input Parameters* through which bottom type and lateral mixing coefficients are specified, *Ensemble Option* for the creation of multiple model configurations based on a specific mesh and bathymetry, and *Input and Output File Naming* to customize the model run file names. A button at the top the *Mesh Creation* component labelled *NITF_Warper* launches the *Image Processing* GUI which handles pixel extraction from multiple image tiles and processes edge and water point locations within a selected region. A secondary page of the RST GUI, *River Discharge and Tidal Forcing Input*, automatically displays at an appropriate time for identifying the open boundaries and specifying the forcing type. Detailed descriptions of the functionality and usage of each RST component is provided below.

1) *Image Processing*: The configuration of a model solely from imagery focuses first on the extraction of river geometry from the imagery. The (*National Imagery Transmission Format*) *NITF Warper Image Processing Utility* shown in Fig. 2 handles multi-spectral or pan-spectral imagery. Input requirements include a browse image (identified by a file name that ends with “-BROWSE.JPG”) that serves as the map to navigate interactive selection of a sub-region. Alternatively the user can input the latitude and longitude limits for a sub-region of interest. Within the selected region, the corresponding image information files (“.TIL” files) are identified.

An edge detection algorithm extracts shoreline points that define the river bank from the imagery. Specification of a Reduction Factor controls the granularity and consequently the number of edge points extracted. Reduction Factors with magnitudes less than 4 increase the number of edge points while values greater than 4 lead to a decrease in the number of extracted edge points. A Slope Threshold is defined using a default value of 0.5. Variations in this parameter are not presently supported. Once all input requirements are defined, selection of the *Run* button performs the tiled image extraction and processes the edge and water point locations from the imagery. In the plot window on the right hand side of the RST GUI, the extracted water and edge locations are displayed as an overlay on the imagery within the region of interest.

2) *Computational Mesh Generation*: Generation of an unstructured finite element computational mesh requires a closed shoreline and bathymetry values. An ordered, oriented shoreline is obtained from the edge and water point data extracted from imagery. Processing this edge and water point data into a continuous, oriented set of shoreline coordinates is achieved using the algorithm developed by [4], [5]. Default values for the five parameters controlling edge and water data processing are given as: the averaging box size (5 m), maximum neighbor

distance (30 m), maximum water point distance (25 m), maximum cross-section angle (45 deg), and angle point range (30 deg). The user is referred to [5] for details regarding the specification of these parameters if an unsatisfactory shoreline results from the default specification and modified values are needed. Alternatively, the shoreline may be hand-edited by selecting that option in the RST GUI.

The RST automatically removes spurious segments and mismatched segment ends from the shoreline data. Furthermore, open-ended shoreline pairs are automatically closed with straight-line segments. These straight-line segments are then flagged as boundary forcing segments (e.g., named river mouths) that are later interactively processed to apply boundary forcing values. The closure of boundary segments is imperfect due to the complexity and highly variable nature of river geometry, so any end-members of the shoreline that are closed (all shoreline data must form a closed loop) but not flagged as forcing segments must be identified interactively. This task initiates after the mesh generation process.

The specification of bathymetry or water depth within the shoreline boundaries is the next step. If known, water depth values can be read in from a file in the format of longitude and latitude coordinate pairs with an associated depth value over the entire region defined by the shoreline boundary or in a localized area contained within the river domain. If bathymetry is unknown anywhere or everywhere within the define shoreline, synthetic bathymetric profiles can be used to assign water depths throughout the domain. The synthetic profiles are constructed using a parabolic functional variation, in which the slope and depth of the profile is controlled by specification of a depth factor (1/depth factor). Fig. 4 presents some examples of the synthetic depth cross-sections based on variations of the depth factor, i.e. 0.5, 1.0, and 1.5 moving from top to bottom. A smaller depth factors results in shallower depths and a more gently sloping river bank.

Once the shoreline is defined and water depths are identified within the boundary of the shoreline data, generation of a mesh can take place. The automated mesh generation is achieved using MeshGUI [6], an unstructured triangular mesh generator using depth-based refinement criteria. Default values for the mesh generation parameters are set for an initial nodal separation of 10 m with 1 refinement. The sinuous nature of river geometry and the presence of narrow channels dictates the required mesh resolution rather than the value of the water depths. Thus it is critical that a fine initial nodal spacing be specified and the number of refinements be limited to retain a computationally practical problem. The RST grid generation function produces the nodal coordinate list and element incidence list indicating nodal connectivity for an unstructured mesh of linear triangles. The format for this file is defined by the ADCIRC model grid file, fort.14.

At this point the RST will automatically produce a GUI (see Fig. 3) that facilitates the interactive identification any open boundary segments that were not identified as such in the shoreline and mesh generation process (as mentioned earlier). The user will use the GUI to zoom in to any end boundary

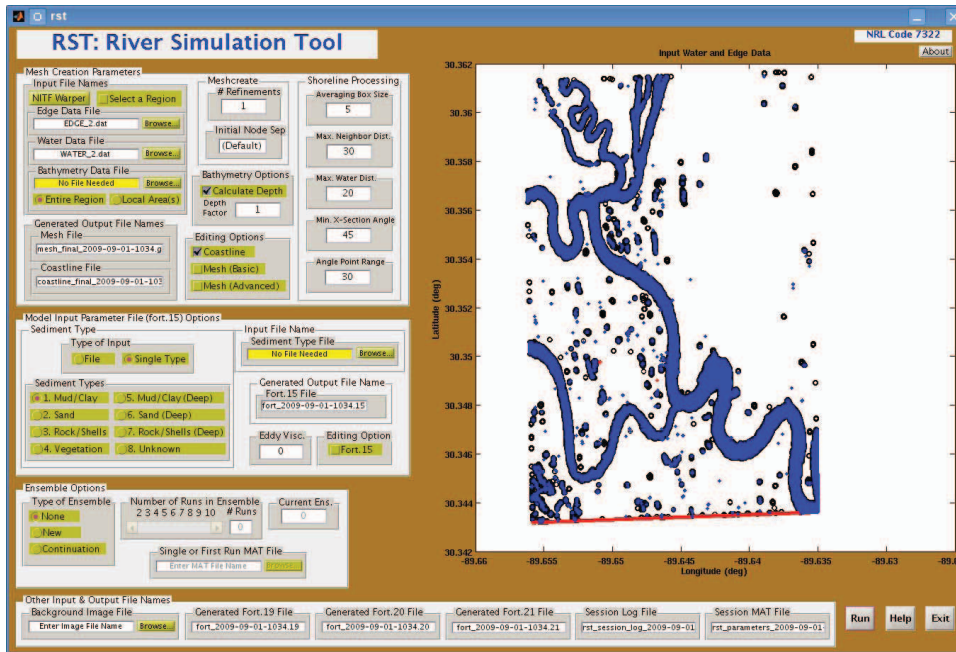


Fig. 1. The Graphical User Interface (GUI) for the River Simulation Tool (RST).

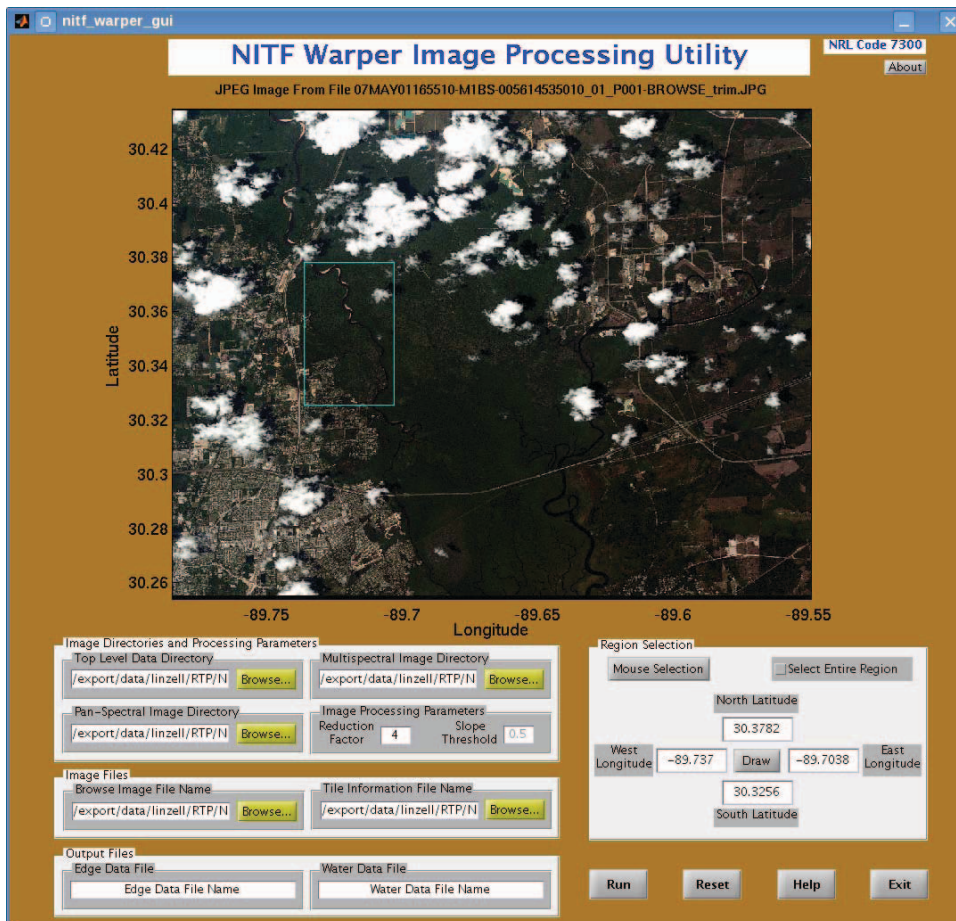


Fig. 2. The GUI for the NITF Warper Image Processing Utility.

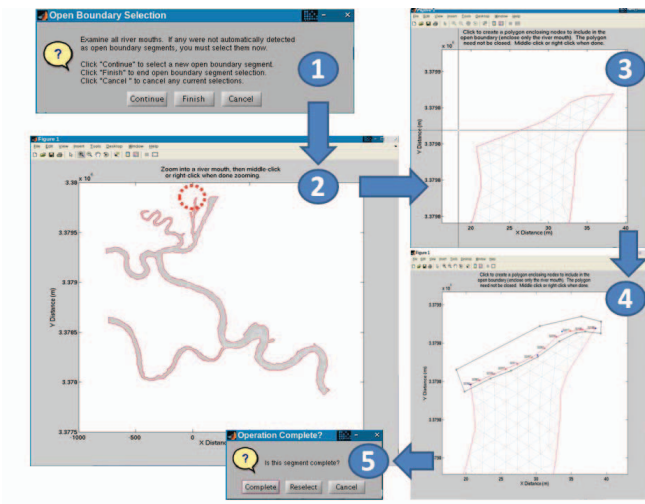


Fig. 3. The sequence of GUI windows for the interactive closure of open end-segments (“river mouths”) and identification of forcing boundaries in the shoreline data.

and select nodes that will form the open boundary. The user encloses the desired open boundary nodes with the mouse, by dragging a rectangular region (“rubber banding”) or clicking on the vertices of a polygon to surround the boundary nodes. This is performed for as many boundary segments as needed. Any user-specified open boundary segments that are flagged as forcing segments will require the specification of forcing data at a later point. Note that some end-members of the shoreline data may still remain “open” or unclosed. For these cases the *Editing Options* can be activated for either the coastline or the mesh to remove small portions of an open segment which can then be closed by the RST software. If the RST GUI successfully flags all open boundaries, then this step can be skipped altogether.

3) *Boundary Forcing Specification*: Once a valid mesh is created the RST automatically advances to the *River Discharge and Tidal Forcing* specification GUI of the the RST (see Fig. 5). It is at this point that the type of boundary forcing, specified flux or specified elevation, is selected and the forcing values specified. The GUI steps the user through each open boundary with a locator map in the upper right-hand corner of the GUI displaying the current boundary location relative to the entire set of shoreline data and a zoomed view of the boundary shown in the main display (see Fig. 6). Options for flux and elevation forcing include a single specified value or time-varying values read in from a file. The user selects appropriate units for the specified forcing and a time interval between records in the data. The direction of the flux is also selected. The directional convention is positive for flux into the domain. The specification of tidal elevation is also an option. Tides can be assigned by constituent using any combination of the eight available primary constituents and user-specified amplitudes or the tides can be extracted from pre-computed tidal databases. Available databases include two global databases, the FES99 [7] and the TPX0 [8], and two

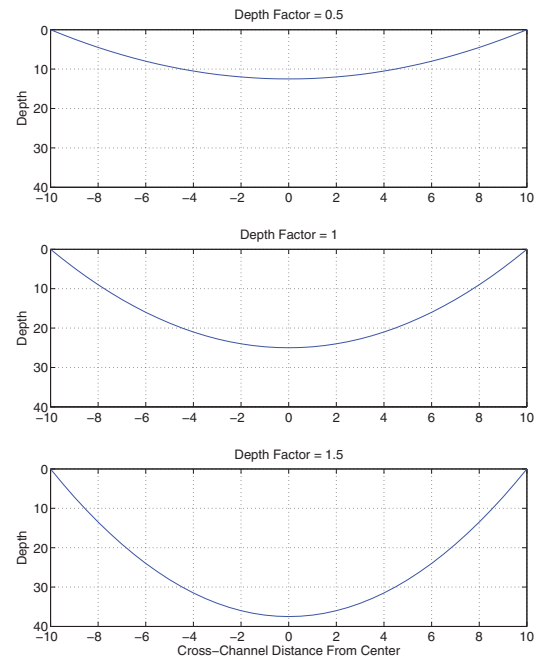


Fig. 4. Synthetic cross-sectional profiles of bathymetry for different values of the depth factor (0.5, 1.0, and 1.5, top to bottom).

US-based databases, one for the north-western Atlantic ocean [9] and one for the eastern-north Pacific ocean [10]. For tidal forcing the date (hour, day, month, year) at the start of the tidal time series and the length of the desired time series must also be provided. Alternatively, a constant water level stage can be specified or a time-varying stage can be read in from a file (fort.19). The RST configures the appropriate elevation time series (fort.19) and/or the flux-specified time series (fort.20) ADCIRC model forcing files based on the user selections.

4) *Bottom Type and Lateral Mixing Parameters*: The bottom type specification links a selected sediment type to a specified Manning’s coefficient according to [11]. A quadratic bottom drag coefficient is then computed based on the water depth using the the Manning’s and Darcy-Weisbach equations [12]. An inherent assumption is that the hydrodynamic simulator is applying a bottom friction parameterization based on the quadratic friction law. The RST interface with the ADCIRC model invokes the quadratic bottom friction parameterization by specifying the variable NOLIBF using value of 1 in the fort.15 parameter file. Supported options include the specification of a single bottom type applied everywhere or a spatially variable sediment type specification read from a file containing longitude and latitude coordinate pairs and the corresponding sediment type number. If sediment type “unknown” is selected a default quadratic friction parameter value of 0.003 is used.

The RST GUI also supports the activation of lateral mixing within the model via an eddy viscosity formulation [2]. Specification of an eddy viscosity coefficient, ESLM, in units of m^2/s is assumed. Typical values can range from 0 to 50 with

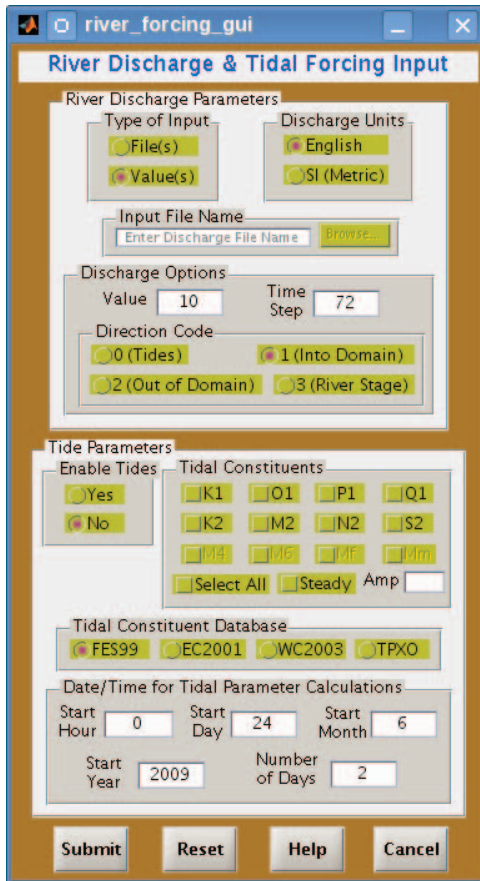


Fig. 5. River Discharge and Tidal Forcing GUI within the RST.

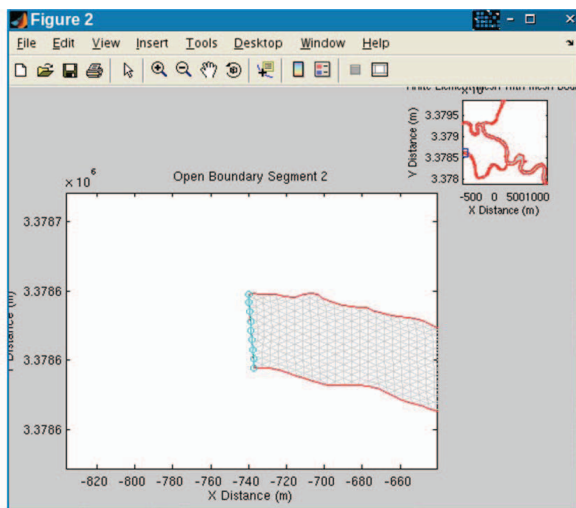


Fig. 6. Locator graphic for the River Discharge and Tidal Forcing GUI.

high-end values applied with when very fine grid resolution is present. The default is no lateral mixing or an ESLM value of 0.

5) *Ensemble Options*: The configuration of an ensemble of model runs is desirable for assessing sensitivities of the predicted currents and water levels to typically unknown parameters and for providing an estimate of uncertainty in the river predictions. Once a single model run is configured in the RST, the user can perturb various values of the specified parameters or forcing to generate a set of differing model runs or ensemble. Within the RST the user indicates whether a new ensemble is desired, the total number of ensemble members up to 10, and the base input (or first run) data. The RST will load the first run data which is the basis for all ensemble perturbations. During the process, the RST indicates to the user which ensemble member is being configured. For all ensemble members the mesh and bathymetry remain fixed.

6) *Input Output File Naming*: The RST provides the user with the flexibility to specify file names that will serve as required input for an ADCIRC model simulation. Additionally a file name can be specified that identifies the background image on which the model geometry is based; that image is used for visual display within the RST. The file types listed in the RST are files for boundary elevation specification (fort.19), boundary flux specification (fort.20) and spatially variable bottom friction coefficient specification (fort.21). The model parameter file (fort.15) and the unstructured mesh file (fort.14) have names specified within their respective sections of the RST GUI, i.e. *Mesh Creation and Model Input Parameters*. All of the RST output files (that become circulation model input files) have names that are created by the RST software. The file names include the date and time that the RST GUI execution was begun, so that ensembles of inputs can easily be identified. The software created file names are displayed in their respective text boxes along the bottom of the RST GUI as shown in Fig. 1. Additionally, an ASCII text log file is created during each RST session and contains program output written to the MATLAB command window. Input and output file names, user supplied and default parameter values, and status, warning, and error messages are preserved in the log file for future reference or for possible troubleshooting. Details on the ADCIRC specific file formats are found at [3].

B. Limitations

In the quest to obtain a functional tool developed in an expedited manner, the RST targets the application of a two-dimensional hydrodynamic model and does not consider the variation of the current over depth or the effects of temperature, salinity or sediment transport on the circulation. To focus development, the ADCIRC model, which is one of the models executed operationally at the Naval Oceanographic Office to support riverine operations, serves as the format template for model input data. The use of other unstructured mesh hydrodynamic simulators are not precluded as most require similar types of information for execution. Meteorological forcing on the river is also neglected as the original vision

of the RST targets applications to inland river reaches and narrow, shallow rivers both of which whose currents are not particularly influenced by wind effects.

One noteworthy caveat in river current and water level predictions produced by RST initiated models is the omission of the river flood plain in the calculations and the neglect of bank over-topping. By creating the computational mesh using shoreline data delineated from imagery, mesh coverage is limited to the water stage of the river at the time of the image data. The image could represent high tide or flood conditions or alternatively, may only capture low water conditions. In the latter case, the water levels and currents predicted will reflect a river geometry that is relevant to low water conditions and will not capture the entire range of possibilities on that river.

One final limitation is more specific to ADCIRC model computations. The supported flux-specified boundary condition does not allow the radiation of energy out through the flux-specified boundary. More recent versions of the ADCIRC model work to overcome this limitation by offering a wider range of dynamical flux boundary conditions. Work-around solutions that include artificial extension of the river channel are also possible (see [1]) but are beyond the scope of the present RST. The present RST does fully initialize an unstructured grid hydrodynamic model from the information extracted from imagery, provide contingencies for forcing and missing data such as bathymetry, and allow for the configuration of model ensembles to better understand the uncertainty present in the forecasts of river currents and water levels produced.

III. RST PERFORMANCE

A. Application to the upper East Pearl River, MS

The RST GUI is applied to a segment of the upper East Pearl River, MS, a region not contained within the NOAA/NOS Medium Resolution Coastline (designed for 1:70,000) but for which Quickbird satellite imagery is available. For this same region in-situ data, such as bathymetry, upstream river flux and downstream tidal variability are also known. What follows is a comparison of river currents and elevation produced by a model initiated from imagery through the RST to one constructed using more traditional methods and validated against observational water levels and currents. This model is labeled “truth”.

The mesh created by the RST from the Quickbird imagery of May 1, 2007, shown in Fig. 7, has 28,300 nodes and 52,471 elements with an average nodal spacing of 5.6m. Default values are used for the shoreline processing and mesh generation as detailed in Section II-A.2. The most notable differences between the two meshes of the same region are the narrower channels and greater refinement within the RST river model. The presence of shadows in the imagery or timing of the image with low water conditions can both lead to a narrow bias of the channel width. The synthetic bathymetry option is applied using a depth factor of 1.0 (see Fig. 4). The resulting bathymetry is depicted in Fig. 8 and compared to water depths in the “truth” model that were obtained from measurements. At the northernmost boundary discharge is specified using a

time invariant value of 500 cubic feet per second (cfs); the southernmost boundary also applies a flux type condition, but a time series of values are prescribed based on the “truth” model computed fluxes at the same location. This magnitude corresponds to the flux value used within the “truth” model of the East Pearl River by [1]. The eastern and westernmost boundaries are closed as no forcing is available for these tributaries. The bottom type is identified as mud/clay which is the default value in the RST. Other default configurations include no lateral mixing, no advection, a three-day simulation period containing 1-day of ramp-up, and a computed time step of 0.2 sec. The average simulation time for the 3-day run on one CPU of an Intel Core Duo (2.66 GHz) processor is approximately 20 hours.

The water elevation and velocity components computed by the RST-configured model are shown in Fig. 9 and compared to the same computed by the “truth” model at three locations identified as node 1, 2, and 3 in Fig. 7. Elevations produced by the RST-configured model exhibit only slight variability in magnitude between each of the three locations along the river. A tidal oscillation is evident but the range of the tidal modulation is reduced and the period shortened when compared to that of the “truth” model. A positive offset of the RST elevations from mean sea level can also be seen in Fig. 9. With respect to currents, the along-channel currents produced by the RST model at all locations are typically greater in magnitude with similar temporal trends when compared to the “truth” model solution. Faster currents are a realistic consequence of the narrower river channels and deeper waters (less influence of friction). Cross-channel currents are small when expected, e.g. the V component at node 3, leading to good agreement between the RST and “truth” model solutions for these situations.

B. Evaluation of RST Ensemble Predictions

We now configure an ensemble of model experiments for the upper East Pearl River. A series of six model configurations include variations of the bathymetry, bottom type, and upstream discharge. The Base model configuration, defined in Section III-A, is labeled “Base” in Table I and applies a bathymetry depth factor of 1.0, bottom type of mud/clay (type 1) and an upstream discharge of 500 cfs. The experiments in Table I allow comparisons between the solutions generated using a) three different bathymetry depth factors, 0.5, 1.0 and 1.5, b) two bottom types, mud/clay (1) and sand (2), and c) three different magnitudes of the upstream discharge, 250 cfs, 500 cfs and 750 cfs. Such comparisons indicate the robustness and sensitivity of the predictions to various parameter and forcing specifications. The RST-configured model solutions are shown in Fig. 10, Fig. 11 and Fig. 12 for the elevation, U -component and V -component, respectively.

Moving top to bottom down the left column and then the right column in each of Fig. 10, Fig. 11 and Fig. 12, the ensemble member comparisons are given as: 1 to 2 (Base vs. low discharge), 1 to 3 (Base vs. high discharge), 1 to 4 (Mud/Clay vs. Sand for Base discharge), 1 to 5 (Base

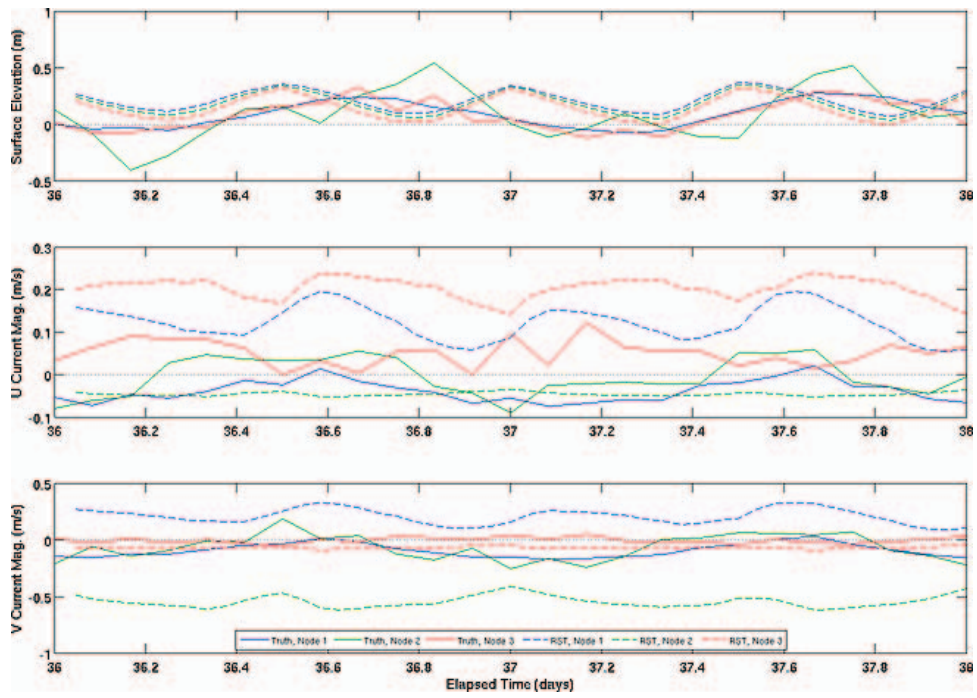


Fig. 9. Comparison of predicted water levels and currents from the RST model (dashed) and the “truth” solution (solid) at three locations in the river, Node 1 (blue), Node 2 (green) and Node 3 (red).

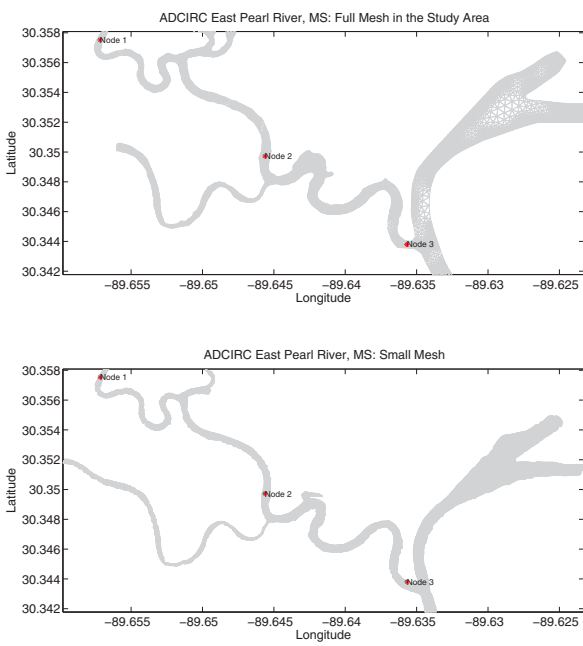


Fig. 7. Comparison of the RST-generated mesh (bottom) and a mesh developed by more traditional means (top).

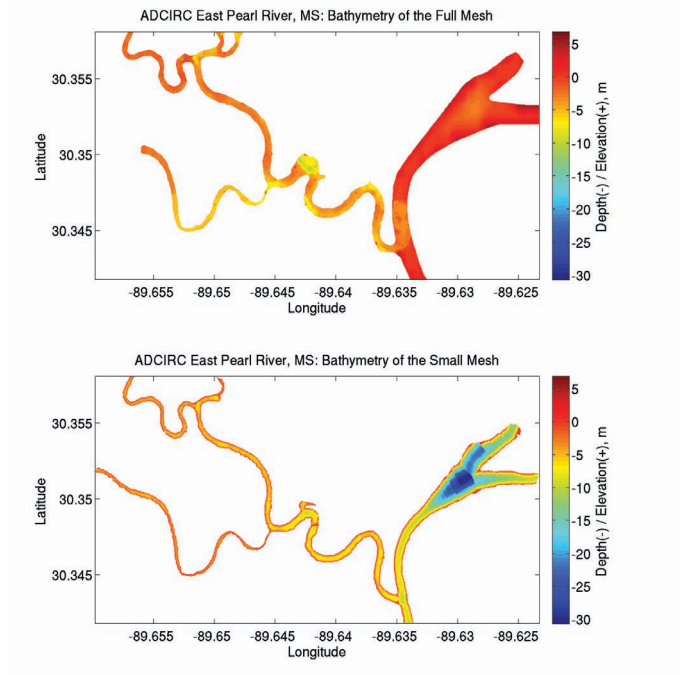


Fig. 8. Comparison of the RST-generated bathymetry (bottom) to that based on available in-situ data (top).

TABLE I
RST ENSEMBLE EXPERIMENTS.

| Ensemble Member | Bathymetry Depth Factor | Sediment Type | Upstream Flux (cfs) |
|-----------------|-------------------------|---------------|---------------------|
| 1 (Base) | 1.0 | 1 | 500 |
| 2 | 1.0 | 1 | 250 |
| 3 | 1.0 | 1 | 750 |
| 4 | 1.0 | 2 | 500 |
| 5 | 0.5 | 1 | 500 |
| 6 | 1.5 | 1 | 500 |

depth vs. shallow depth) and 1 to 6 (Base depth vs. deep depth). Comparisons occur at the three locations (Node 1, Node 2 and Node 3) identified in the bottom right panel of each figure. Considering a comparison between the 250 cfs and the 500 cfs forced ensemble members, as expected, the elevation response is reduced for the low flow condition compared to the Base case but the decrease in water level is not as pronounced downstream to compensate for the identical outflow specified for both scenarios. In contrast, the currents appear insensitive at all three locations in the river to the low upstream flow condition. During high flow conditions, water levels drop below mean sea level over the entire river reach and have a smaller magnitude of the tidal oscillation. The high discharge case is rather influential on currents causing a reversal of direction at all three points in order to maintain the prescribed downstream flux. Moving on to consider the influence of bottom type, the change from mud/clay to sand effectively increases the frictional resistance of the river bed. The result is a reduction of the water level and current magnitudes systematically over the entire river reach. Under fixed discharge of 500 cfs, shallower water depths (depth factor of 0.5) result in a dramatic increase in the water level and current magnitudes in the along-channel direction. This response is natural as the system seeks to preserve mass throughout the system. Shallowing the depth clearly is most influential on the magnitude of computed currents and water levels of any of the factors thus considered. Deepening the water depths (using a depth factor of 1.5) correspondingly leads to a reduction in water level and current strength, though this reduction is not as dramatic as observed when the depth is decreased. From this brief inter-comparison, capturing the shallow water locations and high flow conditions appears to be the most critical for achieving realistic river predictions. Furthermore, we observe that the downstream condition can notably influence computed currents and water level upstream. To remove this dependency if the downstream conditions are unknown, the configured model could be artificially extended in the downstream direction to minimize the influence of any boundary prescription.

IV. CONCLUSIONS

A tool is developed for the rapid construction of a river model using geometry and bathymetry extracted from remote-sensed imagery. Contingencies for parameter specification and boundary forcing are built into the River Simulation

Tool (RST) to handle missing information, not atypical for rivers of military interest. The RST supports the creation of unstructured, meshes of linear triangles and targets the two-dimensional hydrodynamic model formats associated with the ADCIRC model. The interface is user-friendly and requires minimal knowledge of the underlying numerical model. Details of the RST components are presented and an application of the RST to the upper Pearl River demonstrated. The capability of the ensemble feature of the RST to facilitate inter-comparisons of various forcing and parameter specifications is shown. Together the ensemble simulations and comparisons of the RST-configured Pearl River model to a “truth” model of the same region highlight the important role of bathymetry in the computation of river currents and water levels, especially locations of shallow depth. For models representing a limited reach of the river, the specified downstream conditions can be quite influential on upstream calculations.

The RST represents a first capability for rapid river modeling to which a number of improvements and enhanced features are expected. For example, future implementations will include a representation of the floodplain and internal boundaries such as dams, more robust flux forcing conditions, and better quantification of uncertainties in the river prediction through the use of ensembles. Lastly, as in-situ observations become available through river drifters or autonomous underwater vehicles, efforts will focus on including these observations into the prediction cycle.

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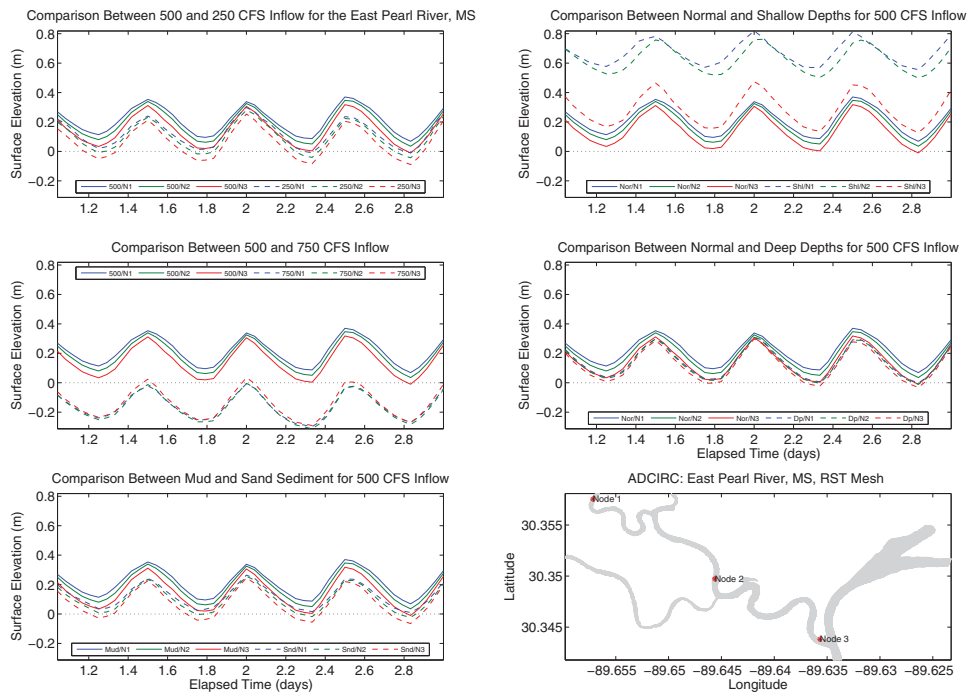


Fig. 10. Ensemble member comparisons of predicted water level from RST model solutions at three locations in the river, Node 1 (blue), Node 2 (green) and Node 3 (red). The Base ensemble member (solid) is compared to the 250 cfs, 700 cfs, sand, shallow depth, and deep depth ensemble members (dashed, top to bottom, left to right).

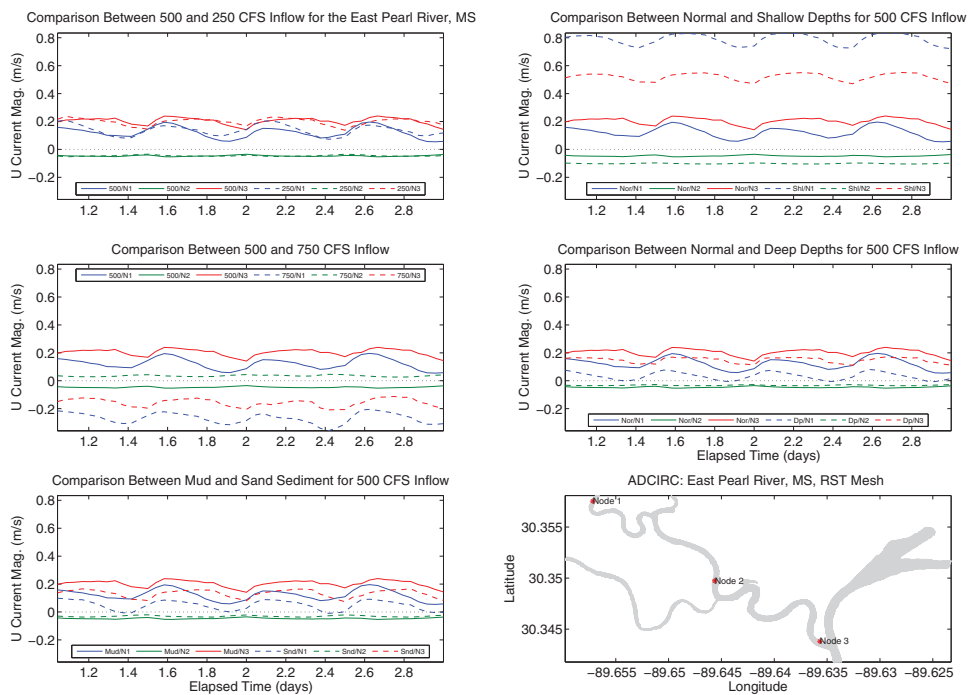


Fig. 11. Ensemble member comparisons of predicted currents (U -component) from RST model solutions at three locations in the river, Node 1 (blue), Node 2 (green) and Node 3 (red). The Base ensemble member (solid) is compared to the 250 cfs, 700 cfs, sand, shallow depth, and deep depth ensemble members (dashed, top to bottom, left to right).

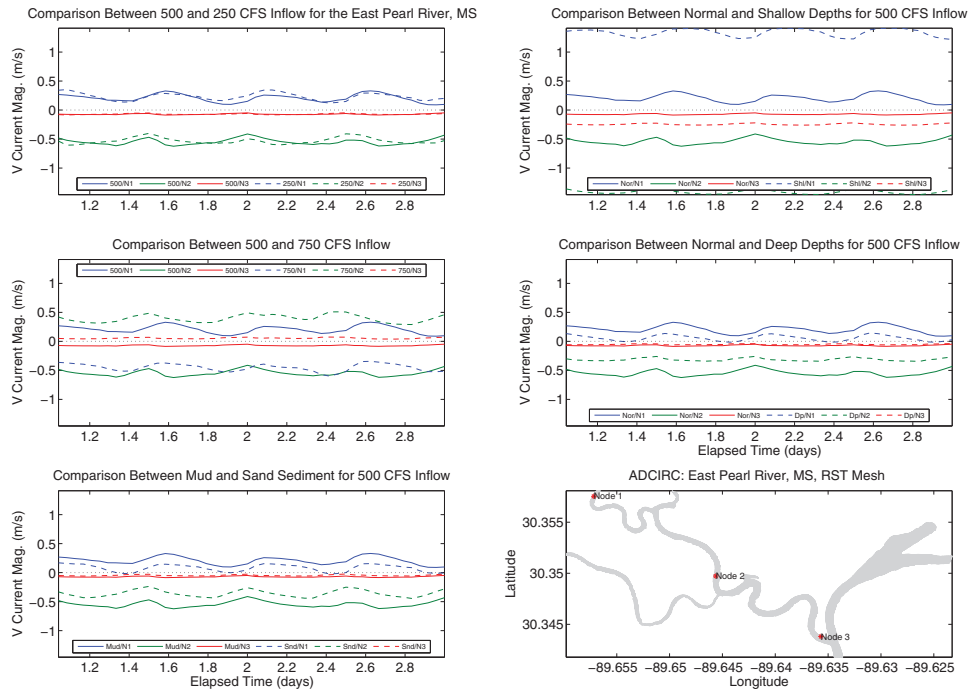


Fig. 12. Ensemble member comparisons of predicted currents (V -component) from RST model solutions at three locations in the river, Node 1 (blue), Node 2 (green) and Node 3 (red). The Base ensemble member (solid) is compared to the 250 cfs, 700 cfs, sand, shallow depth, and deep depth ensemble members (dashed, top to bottom, left to right).

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Abstract: A tool has been developed, the River Simulation Tool (RST), that allows the configuration of a two-dimensional hydrodynamic river model based on imagery-extracted information that defines model geometry and water depth, as available. The RST contains automated shoreline processing and mesh generation capabilities for unstructured grids and accommodates user-specified forcing and parameter values. Alternatively, the RST provides synthetic bathymetry and default forcing and parameter values for those situations in which observational data or information describing the river environment is unavailable. This manuscript describes the components of the RST in detail and its application to the upper East Pearl River, MS. Solutions for water level and currents from the RST-generated river model are compared to a "truth" solution for the same region. Implementation of the RST's ensemble creation feature allows an assessment of the sensitivity of river predictions to the specification of water depth, bottom type, and upstream discharge conditions.

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