SRH-2D Version 3.2.0 (February 27, 2017)

SRH-2D 3.2.0 was created in February 2017 incorporating primarily improved in-stream structure features of previous versions. The version remains true that the in-stream structures are for flow routing only and sediments cannot be routed. Regular sediment transport routing remains valid without in-stream structures.

With SRH-2D Version 3, the mobile-bed, sediment transport module is included. You may also use version 3 to carry out flow-only modeling as it encompasses all the capabilities of SRH-2D version 2.x.

There is currently no User's Manual for version 3; however, I hope that the SRH-2D preprocessor by itself is clear enough to provide guidance on how to use SRH-2D version 3. Many users did just that in using SRH-2D for sediment modeling. Readers may also refer to the sample sediment modeling cases to learn on how to use the sediment module. Report back to me (ylai@usbr.gov) if you have any suggestions on how to improve the preprocessor to make it more user-friendly.

The mobile-bed module has been under research and development for many years at Reclamation. A unique total-load approach was developed and used in which the suspended load, bedload, and mixed-load are modeled simultaneously. The module adopts the time-accurate, unsteady formulation for mobile-bed modeling which includes the time-accurate bed evolution, the non-equilibrium sediment transport equation, and the multi-sediment-size representation. It includes the capability to account for secondary flow and gravity effects on sediment movement in streams within stream bends. A key advantage of the advanced techniques adopted by SRH-2D is that the model is accurate with respect to time evolution algorithm. The penalty is that sediment modeling is usually very demanding on computing time. Smaller time step is often needed for better accuracy, not for stability control.

SRH-2D v3 has been successfully applied to a wide range of projects at Reclamation over the years; it has also been used at selected external institutions. The success of the past experience leads us to release the current mobile-bed version.

I. Major Capabilities with SRH-2D Version 3

SRH-2D v3 mobile-bed module has the following general features:

- Multi-Size Sediment Representation: All granular sediments are divided into multiple size classes with each size class transported and tracked by the model (non-uniform representation).
- Variable-Load: Each sediment size class may be suspended, bedload, or mixed during transport. User may specify the load nature; or SRH-2D will determine the load automatically based on an empirically developed equation.

- Non-Equilibrium Transport: Each sediment size class is modeled with a partial differential transport equation (convection-diffusion type), allowing the transport rate in the non-equilibrium state.
- Multiple Bed Layers: Bed substrate may consist of multiple layers with each layer having difference sediment contents. Therefore, bed armoring and sorting may be simulated.
- Choice of Sediment Transport Capacity Formulae: A number of popular sediment transport capacity formulae are available to use.
- Effects of Secondary Flow and Gravity: Sediment size class movement does not have to coincide with the depth-averaged flow velocity. The sediment velocity may deviate from the flow due to the effects of secondary flow in bends and gravity on a sloping bed.
- Non-Cohesive or Cohesive: In addition to the non-cohesive sediments, cohesive sediment is also modeled that exists on bed.

II. What is included in the SRH-2D v3 Distribution Package?

- Document → This directory contains:
  - User and Theory Manuals for hydraulic flow modeling;
  - A report on how to carry out an unsteady, time-accurate flow modeling;
  - A report on how to use in-stream structures; and
  - Some relevant papers and reports related both flow and sediment transport modeling.

- SRH-2D_Package → This directory contains a number of items; they include:
  - Exec_Bin directory where SRH-2D executable and relevant libraries reside. A user needs to copy "SRH-2D_Package" directory to a local directory, e.g., to C:\SRH-2D_Package, and then the model may be run using the included .bat file;
  - Users are recommended to use the Partial-Interface mode initially. The Customized Mode interface has been fully developed since SMS version 12 and users should get training from Aquoveo LLC directly on how to use SMS to run SRH-2D directly.
  - The ".bat" files, srhpre_64bit.dat and srh2d_64bit.bat are enclosed that may be clicked to run SRH-2D. Users need to open these two files, and edit them so that they point to the correct directory where the SRH-2D_Package\Exec_Bin resides. Note that 32-bit versions are also provided but will be phased out in the future. The "Console" versions are intended for those who would like to run SRH-2D in batch mode.
  - Users may copy the two '.bat' files to any directory where a project resides and run SRH-2D programs by clicking the .bat file.
  - If the 64-bit SRH-2D executable does not work on your PC, you may use the "_NoXMDF.exe" versions. The two versions should produce the same results but the _NoXMDF.exe version does not support XMDF format which is used by SMS.

- If you have a 64-bit PC but execution of SRH-2D 64-bit leads to complaint about ".dll" error, you may google search the error and instructions will be available on how to fix the problem. Likely, you will need to install the 64-bit version of Miscrosoft Visual C++ 2010 Redistrinbutable Package (x64). This program may be found at: http://www.microsoft.com/en-us/download/default.aspx

- Sample_Cases → This directory contains a number of tutorial cases for training purposes. They are recommended for a new user. All cases were prepared to run under the Partial-Interface Mode with _SIF as the input file. They are described below:

  Flow_Modeling_Cases:

  - C1_Tutorial → A simple case to test the FLOW module, and learn to use SRH-2D, as explained in the Manual, Chapter 5. Users may use both the Full-Interface mode (2DM file is sufficient) or the Partial-interface mode (both 2DM and SIF files are needed). Check your results by comparing with the RES, LN1, or PT1 files.

  - C2_Tutorial → A field scale case to learn how to use the MORPH module. Study SIF file to learn how to input extra data related to bed sediment gradation. See the Manual to learn more about inputs and outputs. Note: Only the Partial-Interface mode may be used with the MORPH module; Full-Interface mode does not support MORPH.

  - C3_Sacramento_River → A practical field case, at RM 192.5 of the Sacramento river, to learn how to use SRH-2D with XMDF output format. Both Full- and Partial-Interface modes are used for the modeling. Details of this case may be found in a conference paper titled "Modeling of Erosion and Deposition at Meandering Channels" by Lai and Greimann, ASCE World Environmental and Water Resources Congress, Honolulu, Hawaii, 2008.

  - C4_Dambreak_1D → A simple case to learn how to run unsteady flow with STH-2D. See the Unsteady Flow Modeling write-up and the 2010 FISC Training class document to learn more detail about the case.

  - InStream_Structure_Cases → A number of samples cases are provided to help users to learn on how to use the instream structures modeling. These new capabilities are described in the report, Modeling In-Stream Structures and Internal Features with SRH-2D, located within the "Document" directory. Most samples case are described in the report.

  Sediment_Modeling_Cases:

- C1_Sacramento_River → The case is the same as the Sacramento River case used for flow modeling above except that the mobile-bed, sediment transport module is turned on. The case is used as a sample on how to run the sediment transport model. Note that only Partial-Interface mode is available for sediment transport modeling.

The SMS template file is used only for the Full-Interface Mode as explained in the Manual. Due to potential bugs in some early versions of SMS, the Partial-Interface Mode is recommended if you encounter problems with the Full-Interface Mode. The Partial-Interface Mode has the benefit of (1) more input options, and (2) on-screen help-instructions on how to prepare the input data. For example, the Partial-Interface offers additional modeling options such as "Infiltration" modeling, etc.

III. Key Sediment Modeling Advices

- Computing time can be very high with mobile-bed modeling due to the adoption of the time-accurate unsteady modeling formulation and a few advanced sediment routing techniques. We emphasize more on obtaining accuracy than merely a fast solution. A typical mobile-bed modeling run should be limited to a mesh size of up to 15,000 cells and a total duration of up to 100 days with a given hydrograph. Always start with a very coarse mesh for test runs which may eliminate unnecessary input errors.
  - With a multi-year flow hydrograph, it is recommended that a cut-off discharge value, say q_cut, be used so that discharges below q_cut are not simulated. Smaller discharge flows will not contribute to bed morphological changes. This way, the computing time may be reduced significantly.

- Mobile-bed sediment transport modeling may subject to stability issues despite much efforts devoted for model robustness; flow modeling is much more stable than the sediment modeling. Typically, time step is still the only way to promote stability. For typical field modeling, 1 to 5 seconds of time step are normally used. If the model run diverges with a time step less than 0.1 second, most probably, it is caused by some errors in your input parameters. Supercritical flows may also lead to very small time step and sediment results for supercritical flows may possess very high uncertainty. For mobile-bed modeling, small time step may be needed due to accuracy requirement, not stability control. Occasionally it has happened that the model diverges in the middle of the model run with the correct input setup and a reasonably small time step. For such difficult cases, one may continue the model run using "RETSART" option through the use of _DIP.dat file by: (a) reducing the time step further; and (b) returning the time step back to the previous (larger) value once the time advancement has past the previous instability point.

- SRH-2D v3 allows partition of sediments into a number of size classes. The computing time is proportional to the increase in the number of size classes. Try to limit to one to seven size classes.

- The most important input parameters that affect your erosion/deposition prediction are the predicted bed shear stress (i.e., Manning's coefficient) and the sediment transport capacity equation. Other relevant inputs may include:
    - Upstream sediment supply rate; and
    - Active layer thickness

- Occasionally, you may reduce the relaxation parameter, relax_h, through _DIP.dat file to promote stability. By default, RELAX_H=0.8 is used by SRH-2D v3. You may use RELAX_H=0.3 with _DIP.dat file for a few difficult cases. Further reduction of relaxation is not advised, and code divergence (blow-up) may indicate errors in your model setup.