Next Generation ATLSS Models for Everglades Restoration : Incorporating Variable Meshes

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Objective

- Preparation for the next source(s) of scenario hydrology.
- Models have the ability to utilize the native structure from different hydrology model sources.
- Allow for a comparison across hydrologic model design and underlying assumption.
- Provide a structure for model development and interaction.

ATLSS STRUCTURE

Across Trophic Level System Simulation

Model Type

Individual-Based Models
- Cape Sable Seaside Sparrow
- Snail Kite
- Wading Birds
- White-tailed Deer
- Florida Panther
- Radio-telemetry Tracking Tools

Age/Size Structured Models
- Fish Functional Groups
- Alligators
- Reptiles and Amphibians

Linked Cell Models

Process Models
- Lower Trophic Level Components
- Vegetation

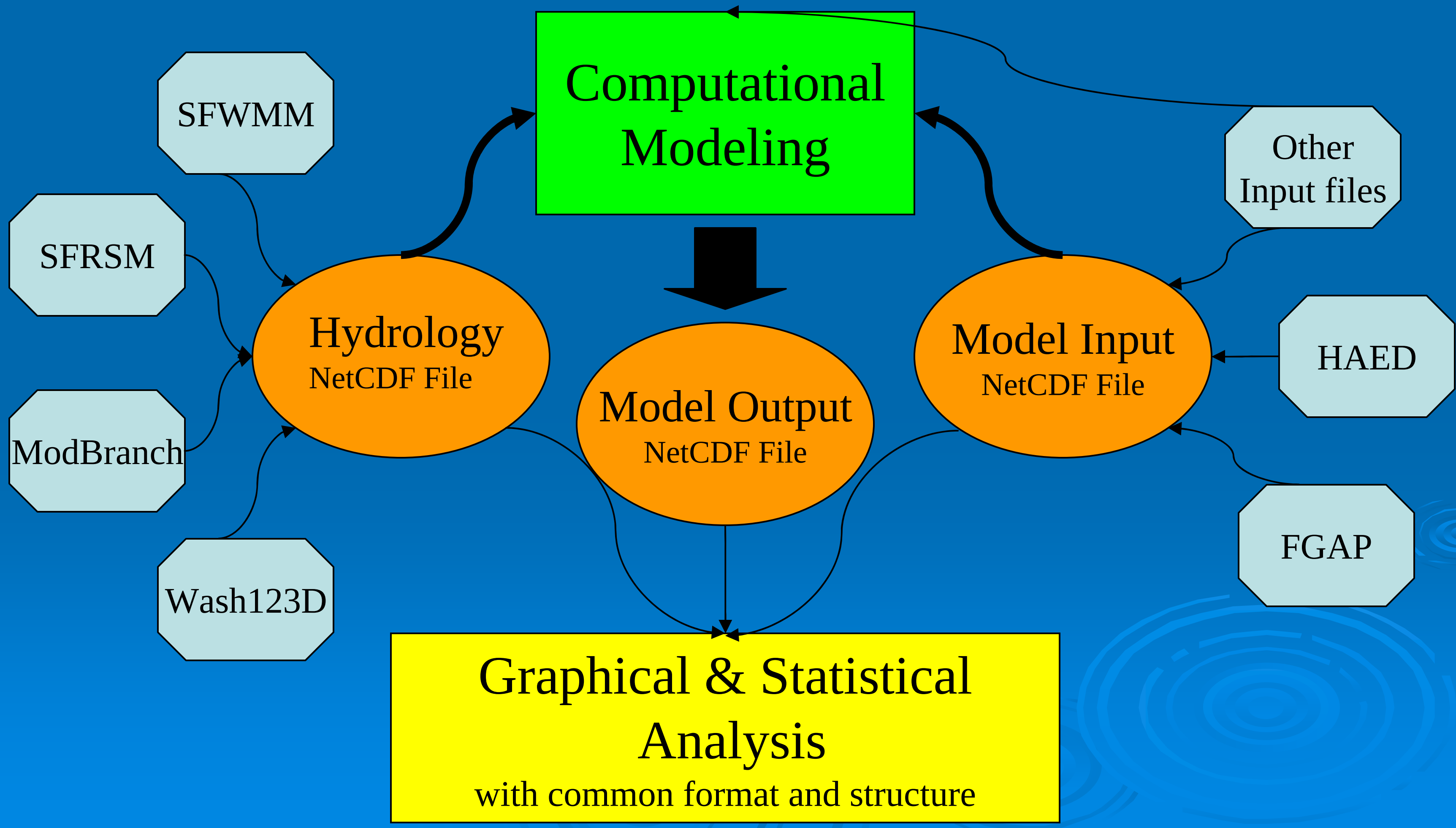
Spatially-Explicit Species Index Models
- Cape Sable Seaside Sparrow
- Snail Kite
- Long-legged Wading Birds
- Short-legged Wading Birds
- White-tailed Deer
- Alligators

Abiotic Conditions Models
- High Resolution Topography
- High Resolution Hydrology
- Disturbance

The Move to a Variable Irregular Mesh

- Hydrology
- Input and Output
- Data structure
- Connectivity and Geo-Referencing
- Input File Generation
- SESI Translation

Data Flow

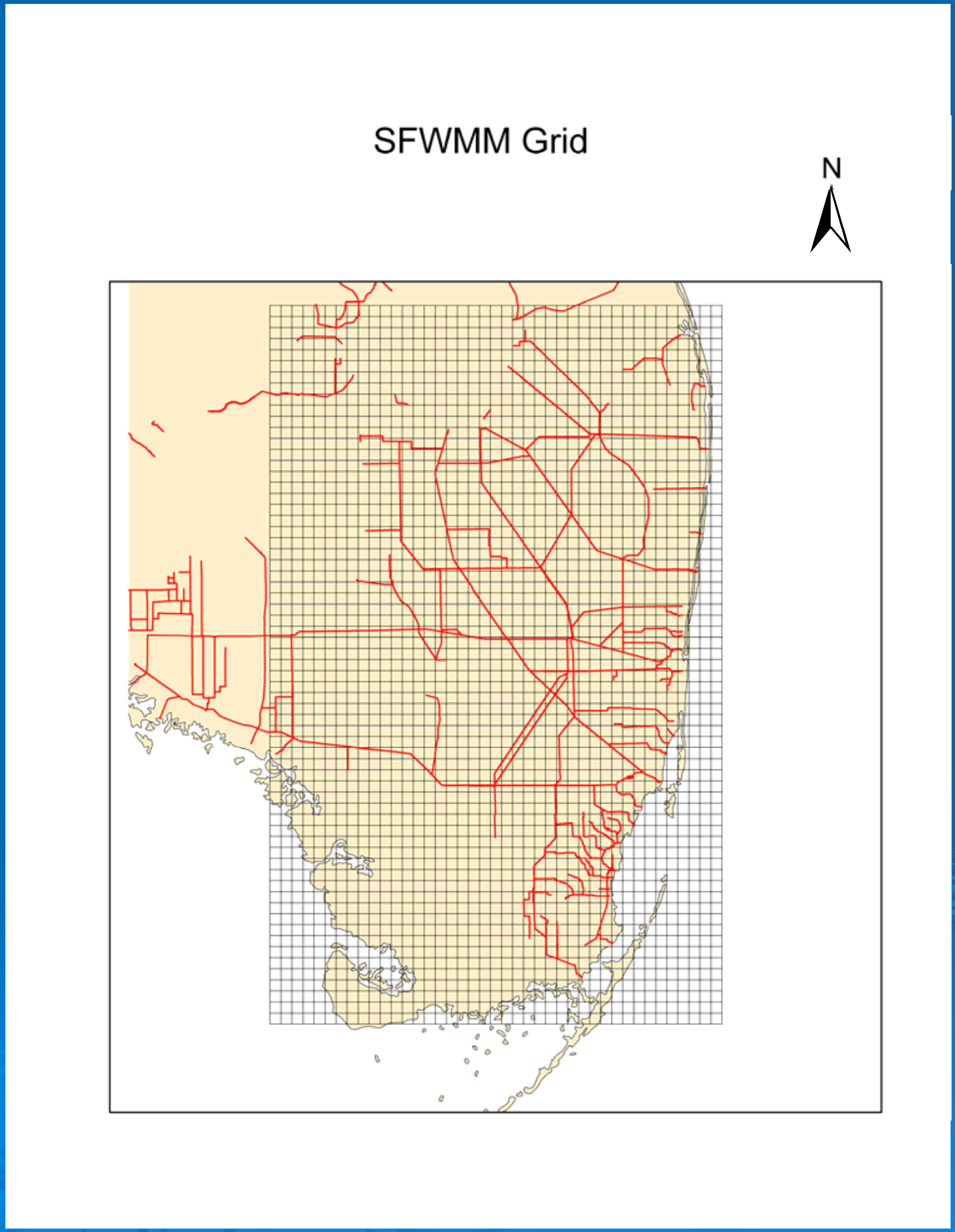


Computational Modeling
SFWMM
SFRSM
ModBranch
Wash123D
Hydrology
NetCDF File
Model Output
NetCDF File
Model Input
NetCDF File
Other Input files
HAED
FGAP
Graphical & Statistical Analysis
with common format and structure

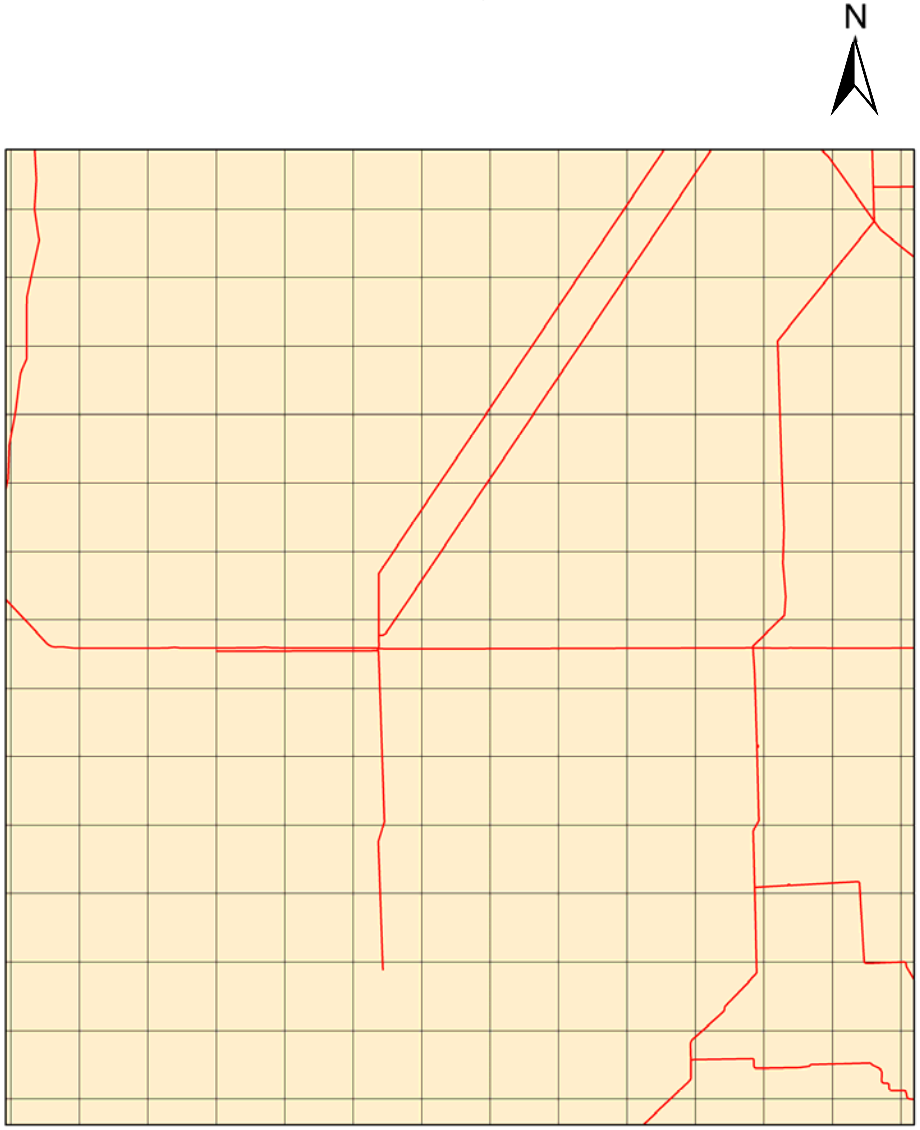
Hydrology

SFWMM

- regular 2 mile grid
- # elements : 2,911
- Multi-year Hydrology Scenario
- Output: unique Binary file format with internal formatting and meta information

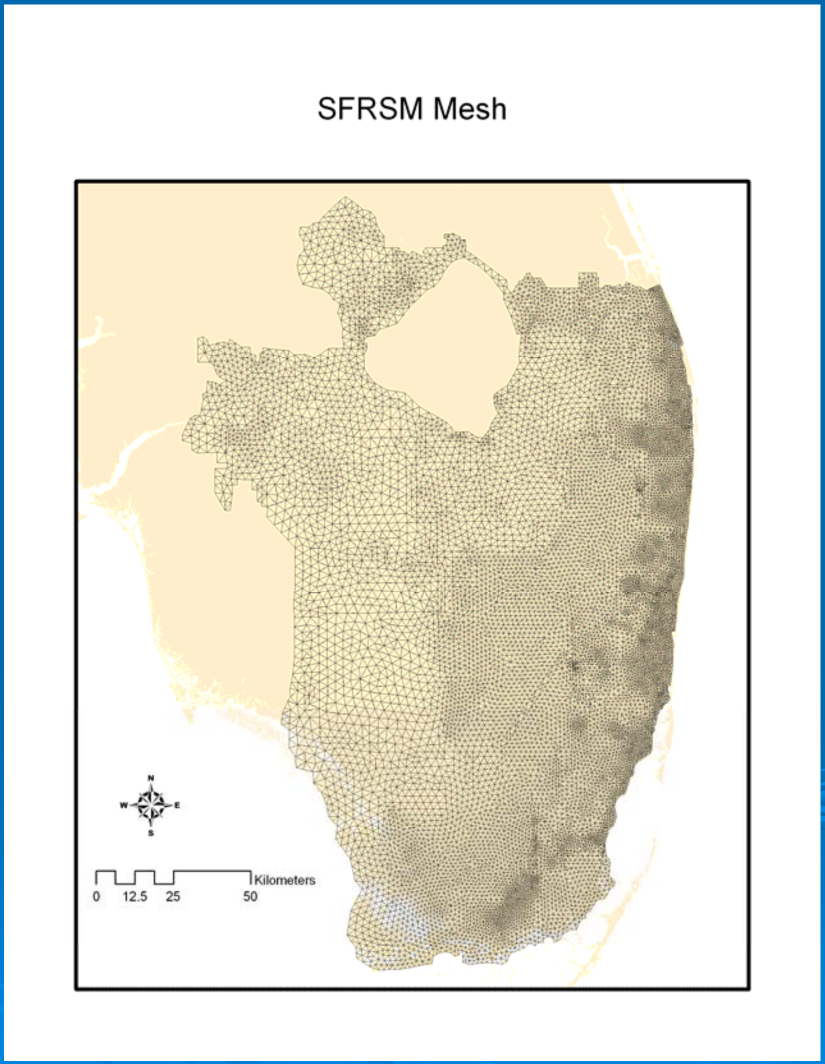


SFWMM 2mi Grid at L67

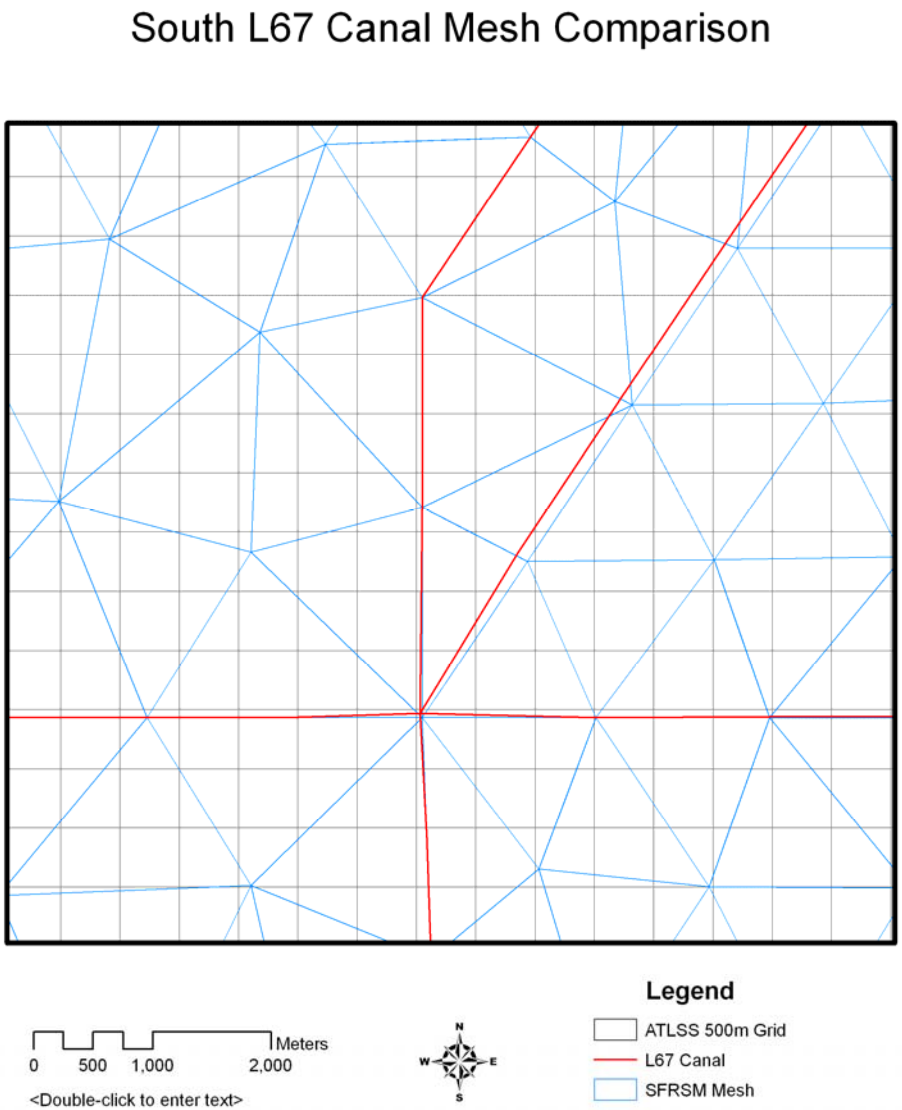


SFRSM

- Unstructured Variable triangular mesh
- # elements :23,916
- Multi-year Hydrology scenario
- Output: NetCDF file containing mesh and hydrology information



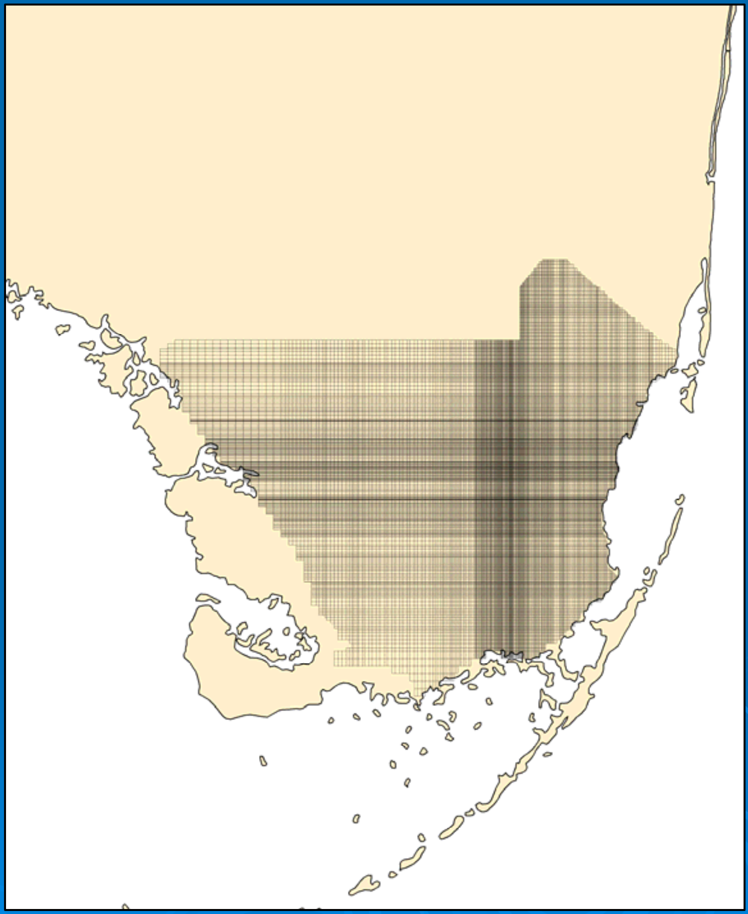
SFRSM Mesh at L67



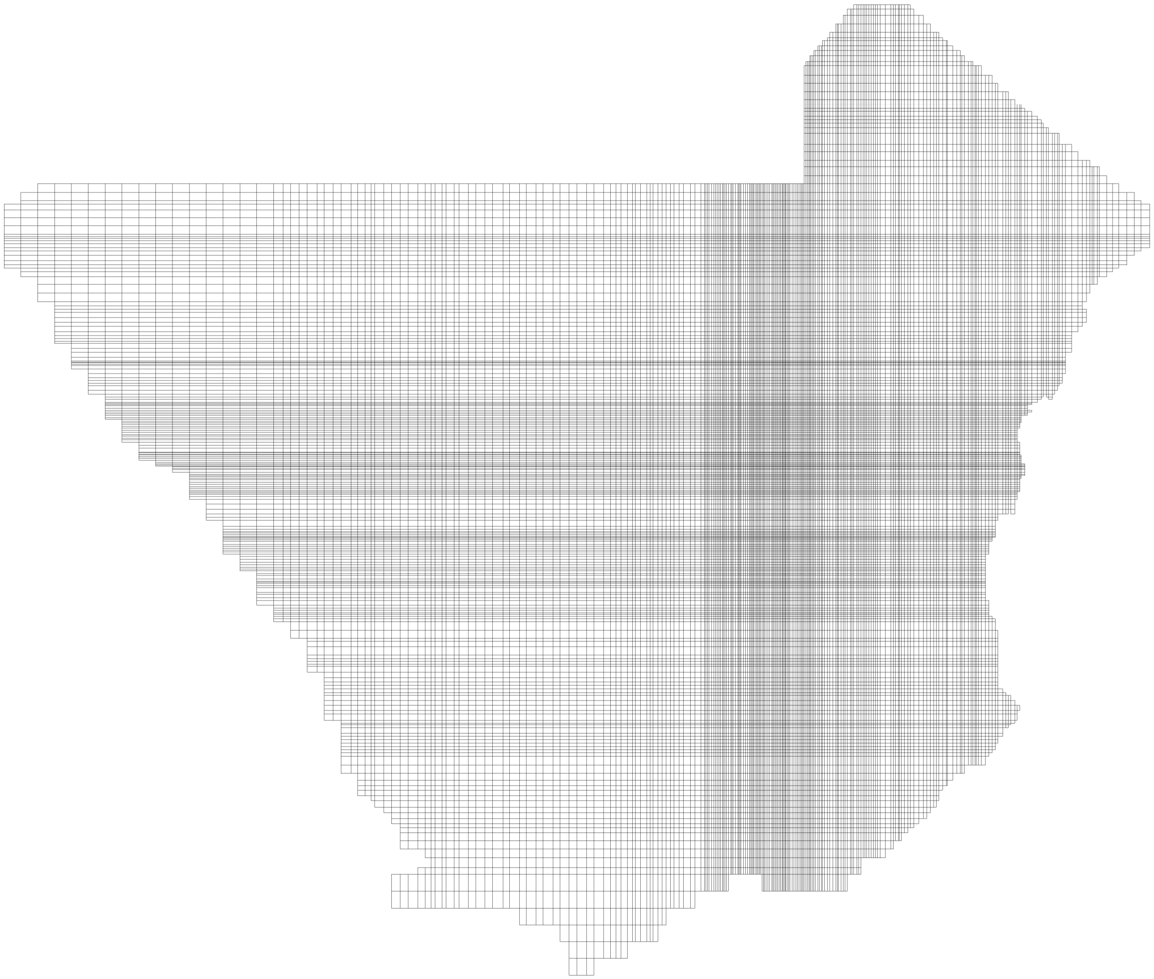
Underlying grid is the ATLSS 500m grid derived from SFWMM and historically used for SESI and other models

ModBranch

- Variable sized Grid
- # elements : 46,197
- Single year hydrology scenario
- Output; a combination of proprietary GMS meshing files, FORTRAN binary data files, and ASCII csv files.

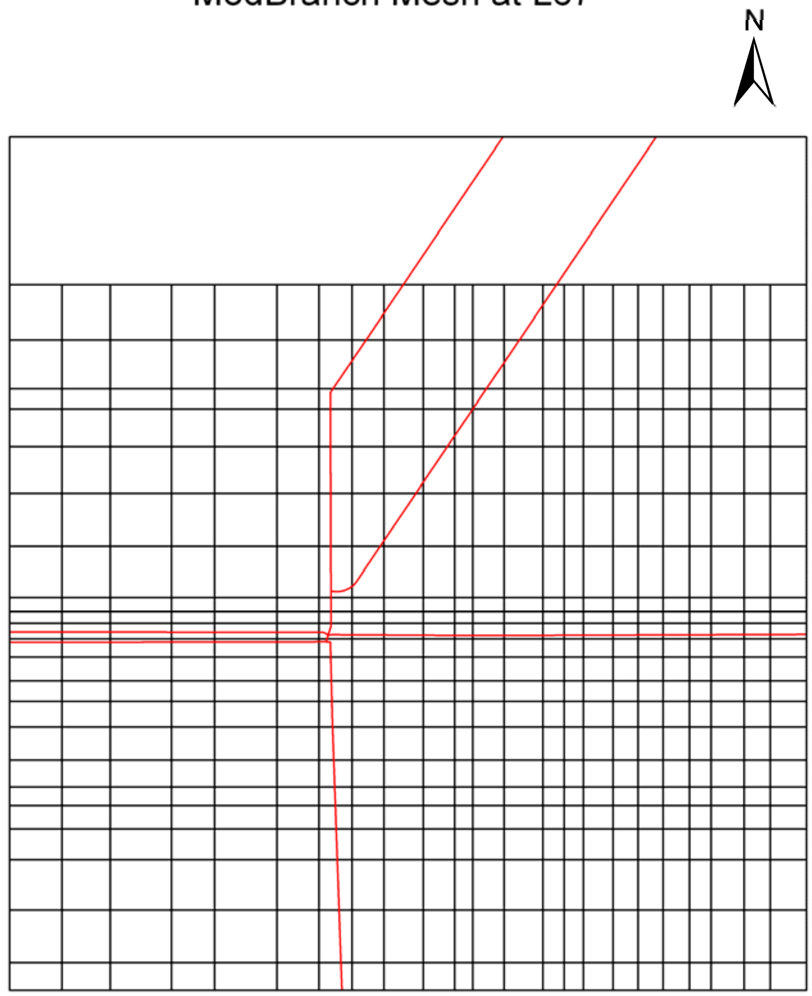


ModBranch Active Elements



Converted from a GMS 2dg file into a Shapefile

ModBranch Mesh at L67



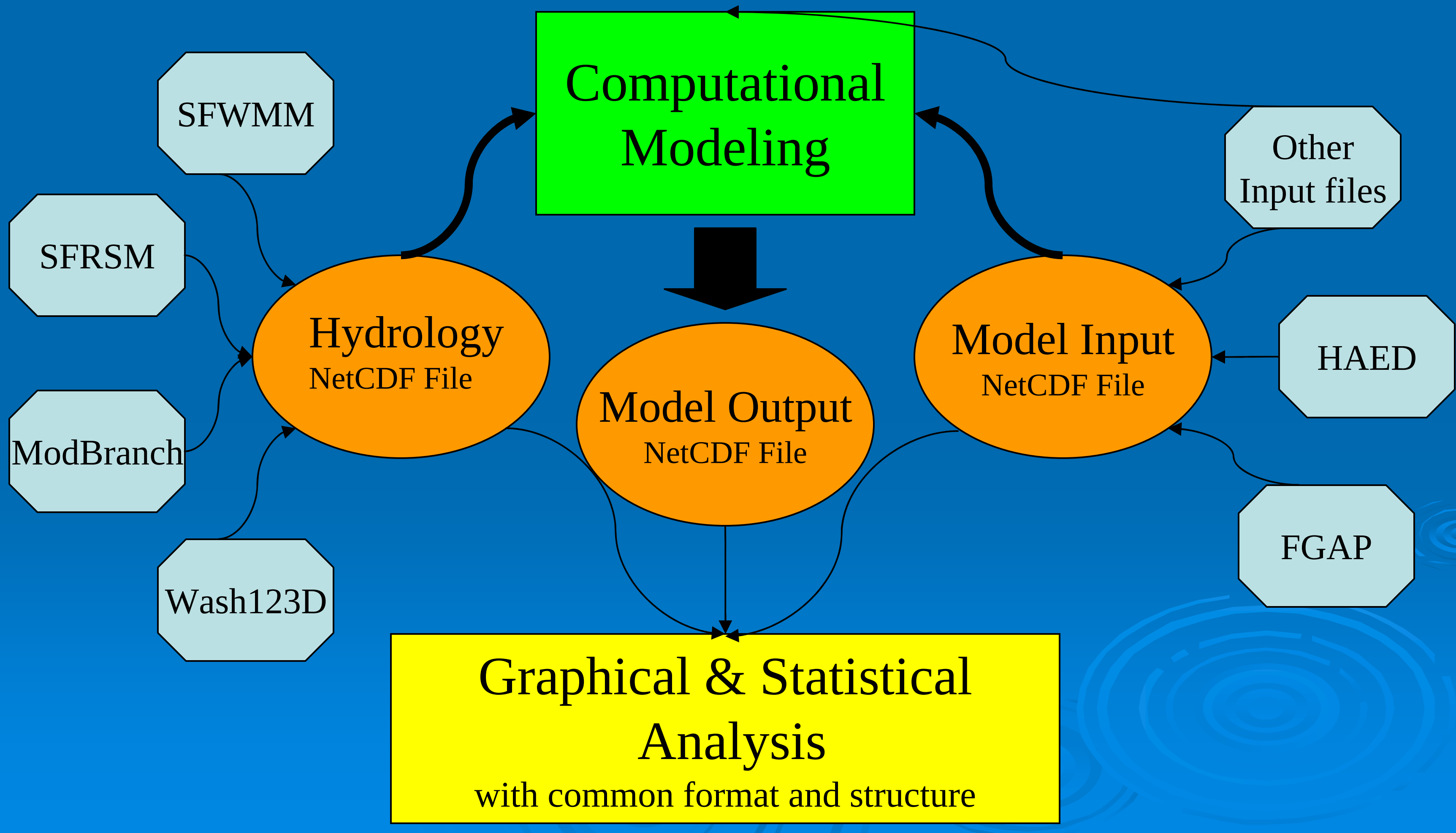
Input and Output

- Each hydrology model has a unique format and structure for the output Hydrology.
- Size and access efficiency necessitate a binary format for the hydrology scenario files.
- Visualization of the resulting output and input data requires a means of formatting the data for viewing.
- Easy of implementation and distribution dictates a format that is not proprietary and is well used and documented.

NetCDF

- NetCDF provides a frame work for array oriented data to be accessed and stored.
- The file is accessible across different operating system, computing platforms, and programming language. This greatly facilitates distribution and utilization of data.
- Libraries and various programs provide efficient access to meet most needs.
- Allows for variable / data commenting within the storage file.
- http://my.unidata.ucar.edu

Data Flow



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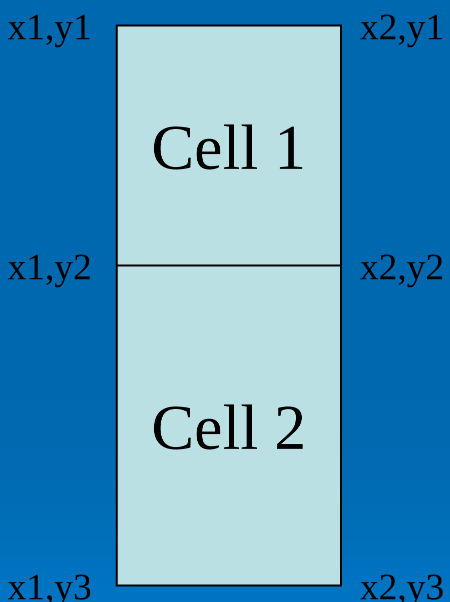
ATLSS NetCDF Storage Structure

• The storage structure is a modified version used by SFRSM.
• The basis is the TIN format, however, data is associated with the elements as opposed to the vertex or node.
• Two major variable define the Mesh: Locations and Elements.
• Locations contains an index of every vertex or node within the mesh.
• Elements contain the indices of the nodes needed to form the shape. a CCW order of connection forms the convex shape.
•The order of the Elements provides a mapping for a single dimension array to hold data information.
• Points, triangles,squares, rectangles, and polygons can all be stored in this format.

NetCDF Storage Structure



Locations

Internal Array Index		
1	x1	y1
2	x1	y2
3	x1	y3
4	x2	y1
5	x2	y2
6	x2	y3

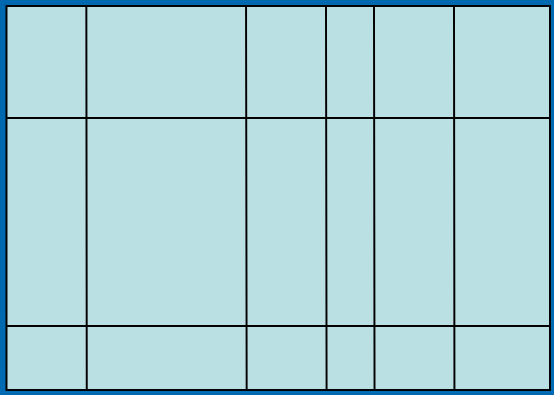
	Elements				Data a	Data b
Cell 1	1	2	5	4	a1	b1
Cell 2	2	3	6	5	a2	b2

Connectivity

Connectivity

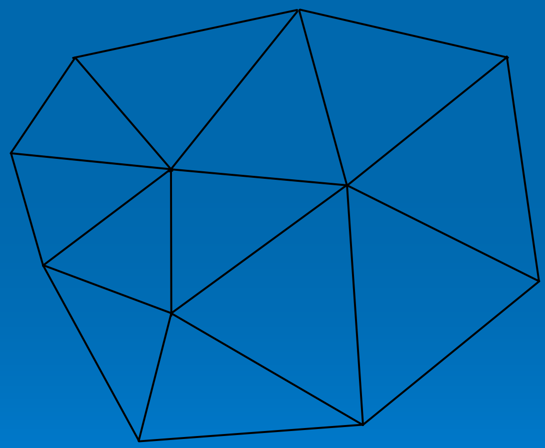
- The regular grid that was used in the SFWMM and by ATLSS has an intrinsic connectivity defined between each cell.
- Row and Column indexing and relative positioning are commonly used throughout the models.
- Each of the variable meshed hydrology Models breakdown this intrinsic connectivity and require a new methodology to be formed to replace that functionality for the ATLSS models.

Irregular Grid (ModBranch)



- Movement of a “cells” distance is variable dependent upon cell column and row.
- Area of a cell is no longer constant.
- Determination where a location falls within the map requires greater care.
- Neighbouring cells CAN still be accessed by incrementing the row and column index.

Irregular Triangular Mesh (SFRSM)

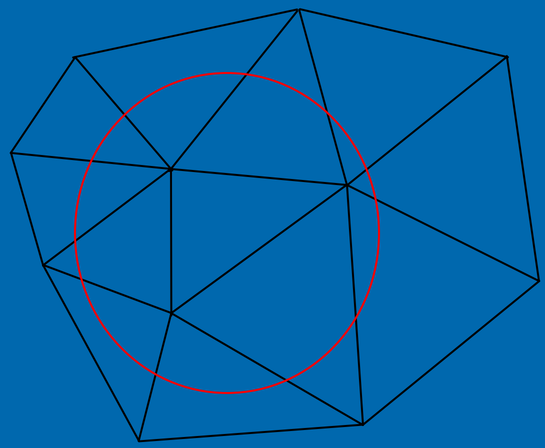


- Determination of neighbour cells is no longer trivial process and depends up you definition of neighbour.
- Relative movement is difficult since there is no easy row and column type index.
- Geo-referencing and location placement within the map becomes more difficult as well.

What is to Be Done? User Defined Neighbourhoods.

- The functionality that has been lost as the regular grid is abandoned as the underlying landscape format needs to be replaced.
- The creation of Neighbourhood Objects will allow the user to generate and store the connectivity that is need by the individual models.
- This will allow a definition of neighbour or movement based on distance or another metric that is appropriate for the model.

Finding a Neighbourhood

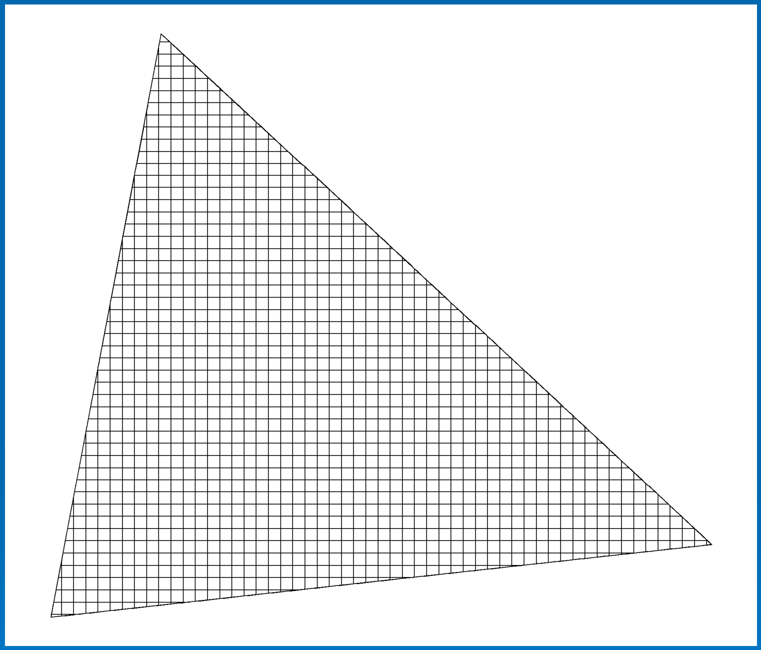


- Using a shape, a neighbourhood can be defined around a the elements, in this example triangles.
- The triangles that “intersect” the neighbourhood can be tabulated. This process can be a pre-processed step to allow for efficient execution of code.
- The definition of “intersection” can be different depending on need. One definition may be whether the centroid of the element falls within the neighbourhood. A second might store the actual area of overlap.
- Explicitly defining the neighbour provides flexibility in modelling and the ability to regain functionality lost by the new meshes.

Input File Construction

- The use of multiple hydrology models requires supporting multiple input files meshes.
- A cookie cutter process is used in many cases to capture the data from a regular grid for insertion into the mesh.
- FGAP is a common input file that is used in the SESI models and is tabulated from the 30 meter resolution file.

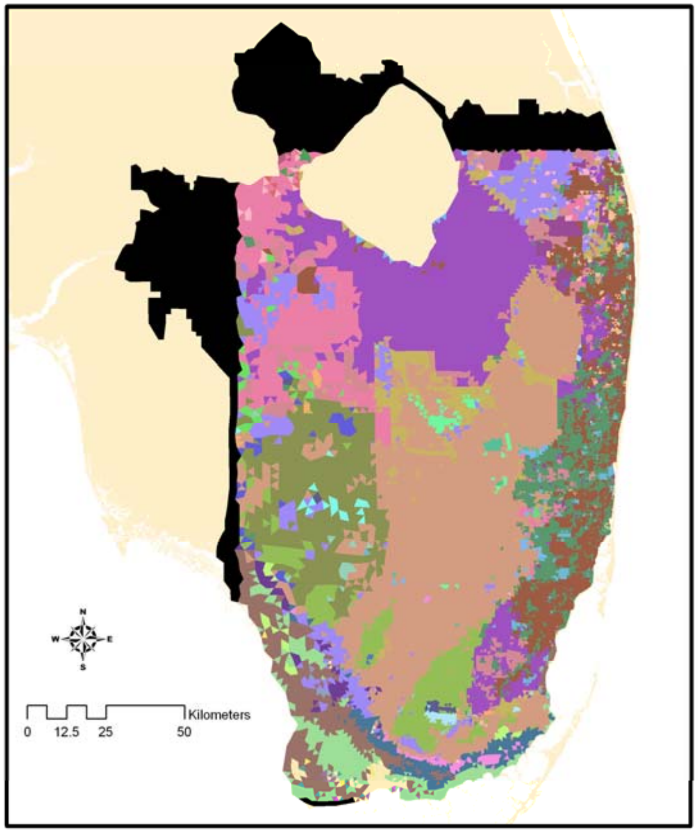
FGAP & SFRSM Intersection



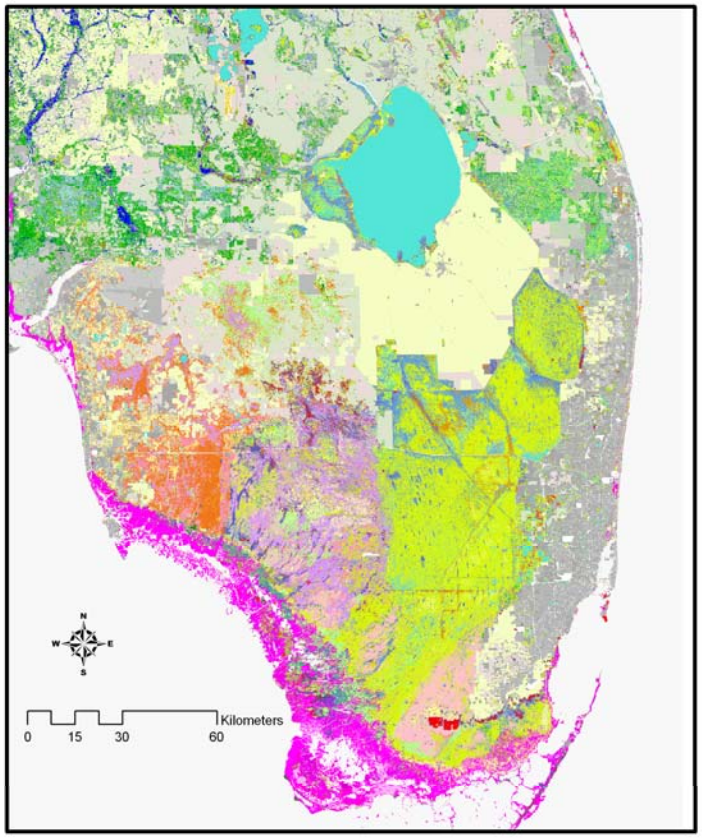
- A SFRSM element will likely encompass many 30m cells.
- Exact area of each cells contribution can be found by calculating the resulting “cut” of the element into the 30m grid.
- Each element can then have an exact breakdown of the quantity of each vegetation type along with a determination of the dominant type
- Care must be taken, since intersection can result in longer narrow triangles that are not well behaved in many numerical calculations.

Resulting SFRSM FGAP

SFRSM FGAP v6.6 Interpolation



FGAP v6.6



Note : Differing color maps are used for the SFRSM FGAP and FGAP.

SESI Translation

ATLSS SESI Translation

- The Creation of the Landscape v3 classes creates the machinery for the translation of the models to utilize hydrology based on a variable mesh.
- The ATLSS SESI Deer model has been mechanically run on mock hydrology scenarios.
- Further evaluation will be able to be performed as scenario from SFRSM become available.

Enhanced Comparison

- The Implementation allows the converted SESI models to run, using the exact same code and compilation, on a wide range of hydrology models and scenarios including the original SFWMM.
- The same SESI model can thus provide a common comparison between different scenarios as in the past with the added ability to compare across different hydrology models.

Conclusion

- Provides a structure for future scenario evaluations to be utilized with existing models.
- Tools for development of New models.
- Structure of Input and Output for utilization, comparison,and visualization of model as well as hydrology data.