Upgrading the Grid-Based Discretization Scheme in SWAT

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Some Aspects of Spatial Discretization

Simulation of the hydrological balance is essential for many watershed applications. The first step in setting up a watershed simulation is to discretize the watershed spatially, i.e. define the spatial arrangement of the watershed elements, such as sub-basins, reach segments and point sources (Neitsch et al., 2010). Until now, the Sub-Watershed Discretization (SWD) has been the most common technique.

The SWD divides the watershed into a number of sub-watersheds or sub-basins based on topographic features. These areas may in turn be divided into Hydrologic Response Units (HRUs). Each HRU represents a part of a sub-basin with comparable land use, management and soil attributes. Although areas with specific attributes may be scattered throughout a sub-basin, they can be combined to form one HRU (Neitsch et al., 2010). All SWAT input and output parameters are calculated or averaged at sub-basin (e.g. weather data or channel, slope) or HRU (e.g. soil type parameters or land management) level. Thus, SWD spatial information provided by a Digital Elevation Model, land use and soil type maps are lost during SWAT processing.

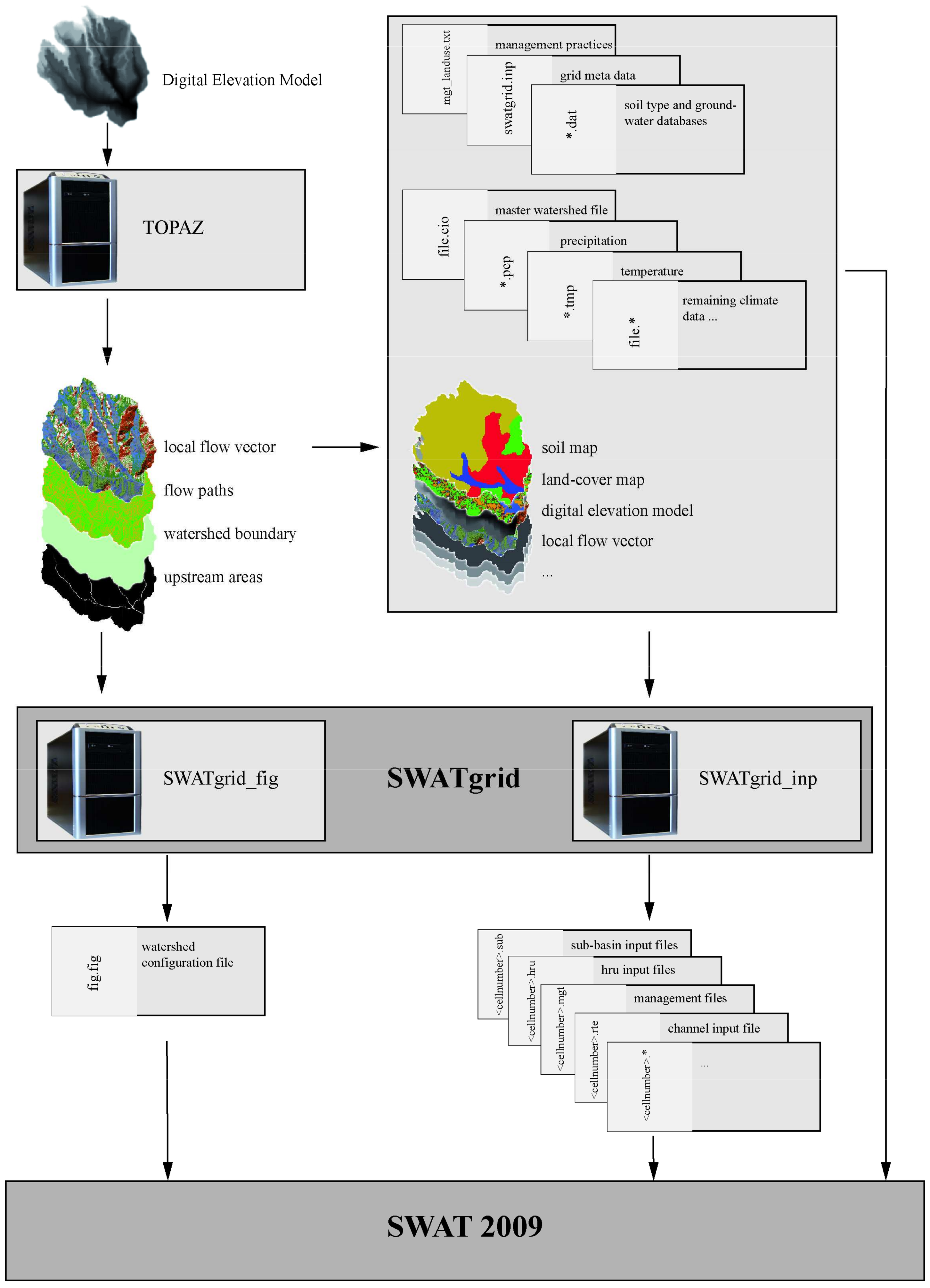

Figure 1: Program architecture of SWATgrid (Rathjens & Oppelt, 2011)

A New Attempt: SWATgrid

A model interface for setting up SWAT based on grid cells was developed to overcome the existing difficulties of spatial generalization: **SWATgrid**. SWATgrid is a command line based interface to prepare SWAT input data for Grid Cell Discretization (GCD). SWATgrid includes three tools (see also Figure 1): **SWATgrid_fig** generates the watershed configuration file (*.fig*) using the digital landscape analysis tool TOPAZ (Garbrecht & Martz, 2000); The remaining input files (*.hru*, *.mgt*, *.pnd*, *.rte*, *.sub*, *.swq*, *.wus*) are generated by **SWATgrid_inp** using raster data. **SWATgrid_out** produces SWAT spatial output parameters, which can be directly visualized and post-processed in ArcGIS.

SWATgrid was tested successfully using the SWAT test data for Lake Fork (Texas, US) (Winchell et al., 2010). Figure 2 presents a subset of the GCD model output. The maps illustrate the spatial distribution of the actual evapotranspiration sum in December 1977 and July 1978. During winter, soil type dependent evaporation dominates the evapotranspiration pattern while in summer this pattern is clearly superimposed by transpiration processes.

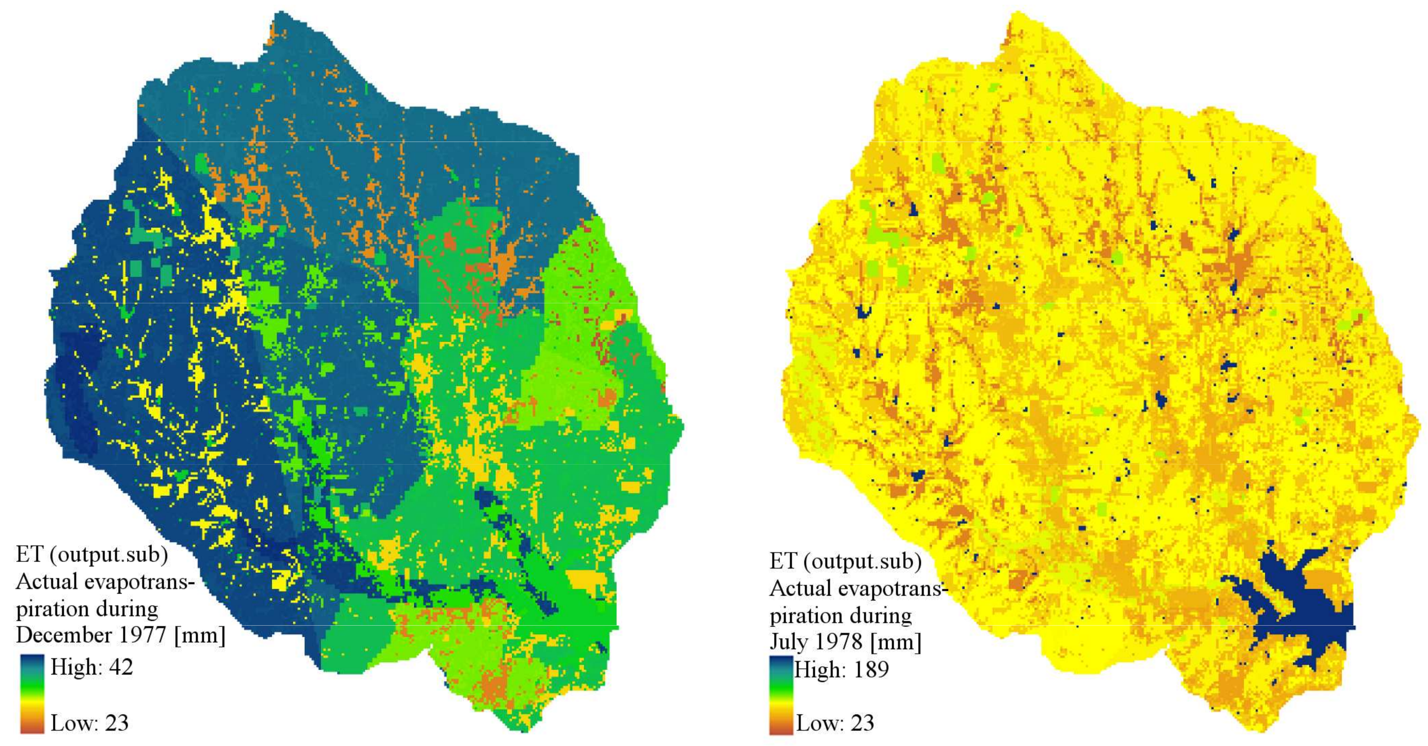

Figure 2: Spatial ET during winter (left) and summer (right) at Lake Fork (Texas, US)

Next Steps

Quantitative Validation - SWATgrid results have to be validated quantitatively in a well-studied area with a sufficient amount of in situ data.

Computation Time - The grid based approach results in a massive increase of computation time caused by the multiplicative number of calculations. Parallel processing would be an option to significantly decrease processing time.

Interactions between Sub-Basins - The current SWAT version does not allow the loadings to interact between cells using the land phase. Therefore, interaction between the grid cells is included in the routing phase, which results in an overestimation of the reach network length. Thus, the grid-based setup may provide inaccurate results regarding sediment transport and nutrient cycling. Arnold et al. (2010) developed a command routing structure that enables a land routing fraction and implemented it in a modified SWAT version. The interaction problem could be resolved if this routing structure is implemented in one of the next SWAT versions.

References

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