Chapter 1
Assessment of NASA's Physiographic and Meteorological Datasets as Input to HSPF and SWAT Hydrological Models

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ABSTRACT

This chapter documents the use of Moderate Resolution Imaging Spectroradiometer land use/land cover (MODIS 12 Q1), NASA-LIS generated precipitation and evapo-transpiration (ET), and Shuttle Radar Topography Mission (SRTM) datasets (in conjunction with standard land use, topographical and meteorological datasets) as input to hydrological models routinely used by the watershed hydrology modeling community. The study is focused in coastal watersheds in the Mississippi Gulf Coast, although one of the test cases focuses in an inland watershed located in northeastern Mississippi, USA. The decision support tools (DSTs) into which the NASA datasets were assimilated were the Soil Water & Assessment Tool (SWAT) and the Hydrological Simulation Program Fortran (HSPF). These DSTs are endorsed by several US government agencies (EPA, FEMA, USGS) for water resources management strategies. These models use physiographic and meteorological data extensively. Precipitation gages and USGS gage stations in the region were used to calibrate several HSPF and SWAT model applications. Land use and topographical datasets were swapped to assess model output sensitivities. NASA-LIS meteorological data were introduced in the calibrated model applications for simulation of watershed hydrology for a time

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period in which no weather data were available (1997-2006). The performance of the NASA datasets in the context of hydrological modeling was assessed through comparison of measured and model-simulated hydrographs. Overall, NASA datasets were as useful as standard land use, topographical, and meteorological datasets. Moreover, NASA datasets were used for performing analyses that the standard datasets could not made possible, e.g., introduction of land use dynamics into hydrological simulations.

INTRODUCTION

Hydrologic and water quality modeling, at the watershed scale, involves managing large volumes of data. The management of these large data volumes usually requires the linking of Geographical Information Systems (GIS) and hydrological models. GIS programs are used for extracting and summarizing geographical information from private or public-domain geo-databases for the purposes of watershed delineation, land use characterization, geographical positioning of hydro-chemical point sources, etc. Hydrological models receive formatted input data from the GIS programs and require additional meteorological and water quality data for simulation of hydrology and water quality in the watershed under study. Partially-existent or non-existent physiographic and meteorological data (precipitation, land use, topography, evapo-transpiration, etc.) oftentimes limit the application of hydrological models to certain areas in the US or the world.

NASA topographical and land use products have global coverage and frequent collection times; as such, they are excellent candidates for replacing or complementing datasets that are currently used by the watershed hydrology community. NASA Land Information System (LIS) models are able to generate time-series of meteorological and other forcing data for regions around the globe. Table 1 describes succinctly the standard physiographic datasets currently used by the watershed hydrology modeling community in the USA.

NASA products match some of the current datasets specifications and offer updated physiographic and continuous meteorological time-series as shown in Table 2. The potential of NASA products for their use in watershed hydrology modeling is evident.

Among the wide variety of hydrological models available for watershed modeling, two of the most popular models in the USA are the Hydrological Simulation Program Fortran (HSPF), and the Soil Water & Assessment Tool (SWAT).

HSPF is a public-domain computer program that models and simulates watershed hydrology and water quality using hourly or daily precipitation and other meteorological/water-quality time-series, parameterized topographical and land use information, and measured stream flow and water quality. It simulates the hydrological cycle (interception, run-off, evaporation, etc.) conceptualizing

Table 1. Datasets currently used watershed hydrology modeling in the USA

	Dataset	Provider	Limitations
Topography	DEM: 300 m resolution, NED: 30 m resolution	USGS (EPA, 2010a)	Depending on the size of the watershed under study DEM could result a coarse approximation to actual relief
Land use, land cover	GIRAS: 400 m resolution, NLCD: 30 m resolution	USGS (EPA, 2010b; EPA, 2010c; USGS, 2005)	Both datasets are outdated. The most current dataset is NLCD-2001, based in land use information collected during the 1990's
Precipitation	Gage station records at hourly, daily frequencies	NCDC (NOAA, 2010)	Several stations have incomplete time-series