Abstract of Dissertation

Estimation of Available Freshwater Resources in Cold and Semi Arid Area by a Land Surface Model

（地表面モデルを用いた寒冷・乾燥域における 淡水資源賦存量の推定）

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Water is a basic necessity for sustaining life and development of society. Proper management, protection and exploitation of the water resources is a challenge imposed by population growth, increasing pressure on water and land resources by competing usage, and reduction of scarce water resources in many parts of the world especially in arid and semi arid areas.

The effectual management of water resources needs hydrological components. These components are usually hard to obtain directly from observation and then they must be simulated. The land surface as a key component of climate and hydrological processes controls the partitioning of available energy at the surface between sensible and latent heat, and the partitioning of available water between evaporation and runoff. A number of Land Surface Models (LSMs) have been established and developed for simulating land surface process and estimating hydrological components. These models include radiation transfer, evaporation, transpiration, snow, runoff, and so on considering the effects of vegetation, and solve the energy and water exchange between land and atmosphere as the vertical one-dimensional processes.

This research has aimed to estimate available freshwater resources in cold and semi arid area by a land surface model. MATSIRO (Minimal Advanced Treatments of Surface Interaction and Runoff) land surface model has been used in this study. To achieve the main objective, there were some sub-objectives such as evaluation of applicability of downscaled global data set in regional scale with low density of meteorological stations; providing distributed forcing data including precipitation, air temperature, wind speed, surface pressure, cloud coverage, long and short wave radiation, and specific humidity via limited regional observed data; detecting effective physical process on the simulation; and identifying effective parameters of the land surface model on simulation improvement.

The study area namely Ardebil area with a low density of meteorological stations is located in cold and semi arid area in the North-West of Iran. There is limited by latitudes 37°49'N and 38°30'N and longitudes 47°45'E and 48°40'E. The total area of its main river basin is equal to 4148 km^2. About 990 km^2 of this area is plain and remainder is the mountain area. The annual precipitation in the study area is about 340 mm.

Applicability of downscaled global data set in regional scale has been investigated by carrying out one dimensional simulation of land surface processes in the study area for two years 1987 and 1988. Necessary atmospheric forcing data for this simulation were available as global data sets from ISLSCP-I (International Satellite Land surface Climatology Project) data collection and also as observed data sets from Iran meteorological organization. Required external parameters such as soil type, land cover, Albedo, and Leaf Area Index (LAI) have been obtained from online global data sets. The obtained results showed that using down scaled precipitation data obtained from ISLSCP-I data collection (instead of local observed precipitation data) in regional water balance calculation has made considerable error in simulated runoff.

In order to make spatial distributed simulation of land surface processes with hourly time step and a spatial resolution of approximately 1 km (30 seconds) mesh; the required distributed forcing data have been provided by using available observed meteorological data sets. The three-dimensional IDW (Inverse Distance Weighting) method for incorporating elevation into spatial interpolation of precipitation has been introduced and used. Also precipitation gauge correction considering the wind-induced systematic error of solid precipitation measurements; has been taken into account in providing distributed precipitation data. The evaluation of applicability of regression method in making distributed air temperature data showed that this method couldn't include elevation effect when the standard deviation of observed values at each time step is small.

To evaluate simulated results, simulated runoff has been routed by using TRIP (Total Runoff Integrating Pathway) river routing model and then calculated discharges have been compared with observed ones. Also since the main basin located in Ardebil study area is small basin, the areal average of daily simulated runoff (output of the land surface model) has been directly compared with observed daily runoff at outlet of the main basin. The percentage of area of each grid cell which covered by snow is one of the land surface model's outputs. Satellite based snow covered area data with resolution 8km and 10 days derived from the Pathfinder Advanced Very High Resolution Radiometer Land (AVHRR PAL) data set has been used for evaluation of simulated snow covered area.

Snow/rain separation, effects of snow covered area on air temperature, and soil freezing have been detected as effective physical processes on simulation of land surface process in the cold and snowy area. Using distributed air temperature data provided by lapse rate method improved simulated snow covered area. Applying adjusted air temperature only for snow covered area improved simulated snowmelt timing.

The threshold temperature of snow/rain separation and soil freezing point were identified as effective parameters of the land surface model on simulation improvement. The simulated results showed that increasing threshold temperature of snow/rain separation from 0 ^{o}C to 4 ^{o}C decreased some peaks in simulated runoff where no peaks in observation and decreasing soil freezing point improved the amount of simulated runoff.