Exploring ERA-5 Climate and Runoff Data for SWAT Model Hydrological Analysis.

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Introduction

European Centre for Medium-Range Weather Forecasts (ECMWF) Reanalysis v5 (ERA-5) [1] data integration with the Soil and Water Assessment Tool (SWAT) model [2] is a potential strategy that could be used for accurate and reliable hydrological modelling for sites where it is difficult to obtain gauge station data.

ERA-5, a state-of-the-art global atmospheric reanalysis dataset, provides a thorough depiction of meteorological variables that are necessary as inputs for SWAT. In addition, the runoff data could be used for calibration and validation of the hydrological models.

The study area, The Middle Euphrates Watershed, is located between 29°38'-33°14' east longitudes and 41°09'- 37°56' north latitudes and covers the lands of Malatya, Elazig and Sivas provinces of Turkey. The Watershed covers an area of 16,482 km2 (Figure-1).

Methodology

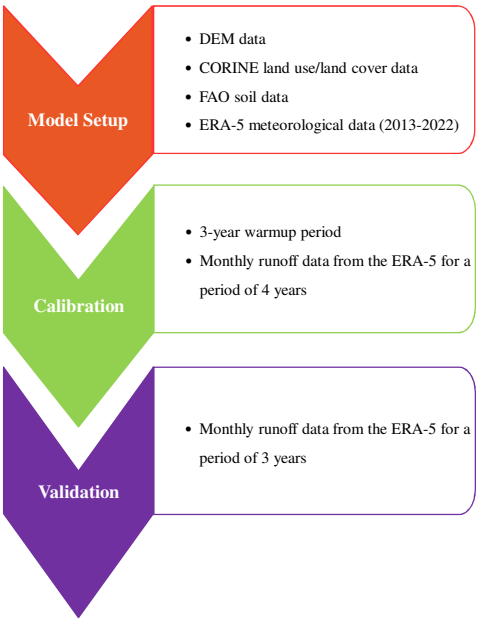

Figure 2. Methodology of the research.

DEM data were obtained from USGS Earth Explorer official website [3]. The chosen DEM resolution for configuring the model stood at 30 meters. The CORINE (Coordination of Information on the Environment) 2018 database was used to determine the watershed's land use characteristics [4]. Soil-related data was obtained from the Food and Agriculture Organization of the United Nations (FAO / UNESCO) world soil map [5].

ERA-5 Meteorological data were used as climate input data for SWAT. The data obtained were daily and covered the years between 2013 and 2022. The data included daily precipitation, maximum and minimum temperature, solar radiation, wind speed and relative humidity. There are 11 stations within the study area (Figure-1). Monthly runoff data from the ERA-5 were used for model calibration and validation.

References

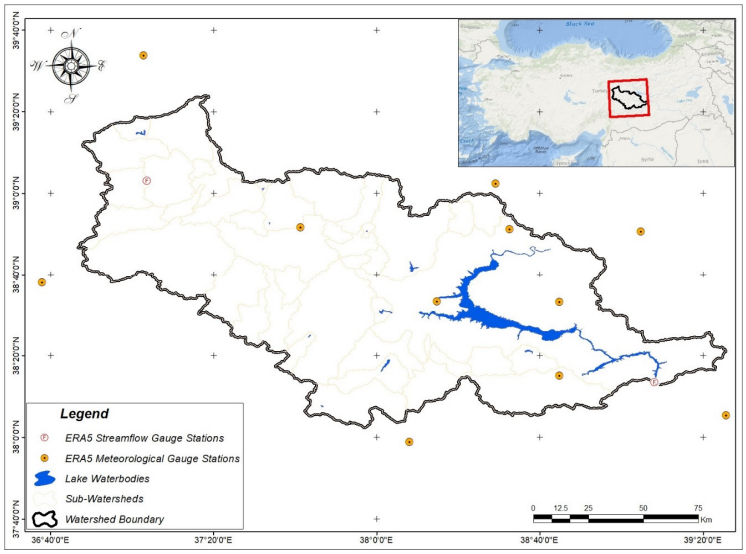

Figure 1. Map of the WWTP locations.

Result and Discussion

- The model setup resulted in generation of 42 sub-watersheds and 567 hydrologic response units (HRUs).
- SUFI-2 (Sequential Uncertainties Fitting Ver-2) algorithm in SWAT-CUP (SWAT Calibration Uncertainties Program) was used to calibrate the model for two imaginary gauge station separately.
- The sensitivity analysis showed that the model was sensitive to 10 key parameters, such as CN2, mgt, SOL_AWC(..).sol, GWQMN.gw, etc., depending on the stations.
- Model performance evaluation was conducted using objective functions, P-factor and R-factor, and objective functions like R2 and NS.
- Calibration and validation outcomes varied among stations, with one station showing good and other satisfactory model performance (Figure-3).

Figure 3. Calibration and validation results.

Conclusion

The methodology employed in this study demonstrates comprehension of hydrological processes within watersheds, particularly those where data collection is hindered by various constraints. Pertaining to the specific study area, the outcomes of this study provides a foundation for future water quality modelling and management studies within the watershed. This research serves as a valuable resource for informing water budget determination, sectoral water allocation, and the implementation of best management practices for sustainable water resource management in the Watershed.

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