

ABSTRACT

Land and water are the precious natural resources that are essential for the existence of life. The management of these resources has become most crucial and simultaneously difficult to manage. The development and management of water resources require thorough understanding of basic hydrologic processes and simulation capabilities at a watershed level. An accurate understanding of the hydrological behavior of a watershed is important for effective management. Various hydrological models have been developed to predict runoff, soil loss, and nutrient losses from agricultural watersheds ranging from plot level to basin level. APEX (Agricultural Policy/Environmental eXtender) model is one of them which has the capability to model the watershed at both plot and field scale effectively and efficiently.

The overall goal of the present study was to understand various hydrological processes at field or micro watershed level and applicability of APEX model in Indian scenario for simulating runoff, sediment and crop yields and validating them through field experimentation at local level and to study the available hydrologic processes and highlight the shortcomings of the model.

An experimental agricultural watershed at Dr Y S Parmar University of Horticulture & Forestry was selected under the present study. The study area has an area of 0.4 ha in the Research Farm, Department of Soil Science and Water Management, College of Forestry, Dr Y S Parmar University of Horticulture and Forestry, Nauni – Solan, Himachal Pradesh – India. The historical meteorological data and comprehensive information on land and crop management practices for crops grown in the study area were collected for preparing APEX model input files. The various laboratory and field experiments were conducted to determine the accurate values of soil properties of different soil layers to provide the soil properties input values in the

APEX model and also to categorize the soil productivity class of the experimental agricultural watershed.

The soil of experimental agricultural watershed was categorized sandy clay loam at surface and loam at subsurface layer, medium quality soil structure, ideal bulk density, neutral pH, normal EC, medium to high SOC, low to medium available N and available K, medium to high available P, medium CEC, high profile water storage capacity, moderate infiltration rate, moderately slow saturated hydraulic conductivity, erodible soil surface in nature. The physical health rating index (PRI) value for the experimental agricultural watershed was estimated as 0.9025. The experimental agricultural watershed was rated as Productivity Class I, which is very suitable for productive cultivation and capable to provide high yields of the crops grown in the watershed.

An experimental set up comprising a 90° V- notch was constructed and installed with an automatic stage level recorder at the outlet for measuring continuous discharge and taking runoff samples for estimating sediment yield from the experimental agricultural watershed. The continuous runoff and sediment yield data were measured during the rainy season from year 2015 to year 2021 for performing calibration and validation of the APEX model.

The mean rainy season rainfall, runoff, ratio of runoff to rainfall and soil loss were observed 732.29 mm, 161.68 mm, 21.99 percent and 2.68 t ha⁻¹, respectively during the entire study period from year 2015 to year 2021 for the experimental agricultural watershed, which is lower than permissible soil loss tolerance limit of the country. The correlation equation between runoff (Y) and rainfall (X) and as $Y = 0.5512X - 8.3443$ ($R^2 = 0.6994$) and correlation equation between soil loss (Y) and runoff (X) as $Y = 0.0164X - 0.0061$ ($R^2 = 0.8352$) were established for the experimental agricultural watershed.

The APEX model for simulating runoff, sediment yield and crop yield from the experimental agricultural watershed were calibrated for the period of year 2015 – 2018, while the model performance were evaluated by considering a validation period from year 2019- 2021. The water balance components for the experimental agricultural watershed were also simulated using APEX model.

The evaluation of model performance revealed that the APEX model performed very well at field scale for predicting surface runoff, soil loss and crop yields for calibration and validation periods for daily, monthly and seasonal time scales in the Indian perspective due to acceptable values of coefficient of determination (R^2), Nash-Sutcliffe Efficiency (NSE), Pearson's Correlation coefficient (r), RMSE observations standard deviation ratio (RSR), Index of Agreement (d) and lower values of Percent Bias (PBIAS), Root mean square error (RMSE), Mean absolute error (MAE).

The calibrated and validated APEX model would be helpful to assess the effect of various prevailing land and water management practices on runoff, sediment and crop yield and would be beneficial in agricultural water management as well as various soil and water conservation practice in Indian scenario similar to the study area.

Keywords: APEX model, agricultural watershed, land management, water management, crop management, soil loss.