Innovative Rainfall Simulator Design for Moving Storm Scenarios with Different Storm Patterns

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Rainfall simulators are widely used in the field of hydrology, biosystem engineering, agronomy, and geomorphology to understand the processes involved in these disciplines. Usually, rainfall simulators are not able to generate spatio-temporal variation in rainfall intensity simultaneously unlike natural conditions. Majority of methods used in rainfall simulator studies assumes that the rainstorm reaches instantaneously and remains steady over an area for a certain time period. Hence, most of the rainfall experiments ignore the effect of runoff response caused by moving storm across a watershed which results in under or over estimation of runoff peaks. Considering these limitations of traditional rainfall simulators, we are developing an advanced rainfall simulator using eleven full cone nozzles to simulate moving front storm. These nozzles can generate rainfall intensity in the range of 65 to 190 mm/hr at a pressure range of 50 kPa to 180 kPa with a varying height from 1.5m to 4m above the ground surface. All the eleven nozzles are controlled by flow control valves and the valves are individually regulated by servo motors. Arduino Mega microcontroller system is used to control all the servo motors to generate variable rainfall intensities. Further, we have developed a mobile application for Android users to regulate all the valves of rainfall simulator. This simulator is able to simulate nearly natural rainfall conditions in the controlled environment in four different patterns i.e. uniform, advanced, delayed and intermediate. A tray of 250cm×140cm×50cm has also being designed and fabricated to conduct different hydrological experiments. This tray is designed with a provision to generate and record overland, subsurface and base flow. Tray area can also be divided in three partition to analyze three different soil conditions simultaneously. Slope adjustment, leachate collection unit and piezo metric head measurement unit are also incorporated in this experimental tray. Overall, the whole rainfall simulator with tray can be used to study the impact of moving storm on soil erosion, infiltration, and runoff in the simulated near natural environment along with pollutant transport mechanisms. This study is being focused on detailed analysis of moving storms and their impact on hydrograph characteristics, especially in terms of time of concentration (tc), time to peak (tp), and peak discharge (Qp) for two different storm directions (upstream and downstream) with different storm movement velocity and rainfall intensity.

Keywords: Rainfall simulator, Moving Storm experiments, Spatio-temporal variation

