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A new, integrate and parsimonious hydro-geomorphological and hydro-chemical approach in multi-purpose catchment hydrological response analysis.

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In recent decades, many efforts have been spent in hillslope and catchment hydrology to define, at multiple time-space scale, sources, timing and pathways of runoff generation during storm events. To this aim many researchers have employed more or less sophisticated chemical and isotopic tracers to separate the water components and individuate their space-temporal variation in a catchment. A gap exists between simple lumped hydrological models at basin and long-term scale and sophisticated hydrological distributed models based on numerous quantitative parameters and expensive data collection at parcel/watershed and short-term event scale. To overcome this gap, the authors proposed an interdisciplinary (hydrology and geomorphology) and integrate (hydro-chemical) approach, tested in rainfall-dominated, forested and sandstone research catchments of the Cilento UNESCO Global Geopark by using an inexpensive, parsimonious and effective protocol, as suggested by the UNESCO Biosphere2 Program for water resource assessment and management. Seasonal analysis were performed on the daily data recorded at the outlet of the catchment during the 2013-2015 and was based on a modified mixing law procedure using discharge (Q) and Electrical Conductivity (EC) data, collected at selected groundwater, sub-surficial and surficial monitoring stations. The calculations allowed to derive a comprehensive "chart" with Q-EC hysteretic fields delimited by three upper and one lower boundary curves and where each field is representative of specific mechanism, source area and timing of runoff generation. The estimated intersection points between the three upper consecutive curves is the Q-EC threshold values for that another mechanism starts and hydro-dynamically interacts with the previous one. In this way, the waters become mixed before to reach the streamflow. This is explained by a typical "threshold system", where each "tank" or "reservoir" remains independent during low magnitude events, but interacts physically and functionally at higher event magnitude with other tanks, inducing superposed hydrological mechanisms and complex hydro-chemical water mixing along the floodplain banks, the riparian corridor scarps and the colluvial hollows. In order to confirm this approach at shorter time than daily, during the 2016-2017 years, a 5-minute Q, EC, air/water Temperature, Rainfall and Soil Humidity dataset was collected. A good agreement resulted between daily and 5-minutes data analysis, but short-term anomalies affect robustness of the data fitting. Morever, the data were aggregate at 10, 20, 30 and 60 minute intervals to check the best data averaging and to optimize the time-step interval for multi-purpose monitoring activities. The hourly time-step shows the better agreement with the boundary curves previously defined at daily time intervals, requiring less time and computer resources during the data analysis than the sub-hourly dataset. The sub-hourly time-step allows to better reveal and understand short-term Q-EC anomaly pulses, identifying hysteretic fields derived by human activities (pollution) or no-hydrological processes (i.d. shallow landslides) entering in the streamflow and quickly disappearing, as detected by the contemporary field surveys.