CATCHMENT WETNESS ASSESSMENT BY RIVER FLOW MEASUREMENT

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Soil moisture is a very important factor which influences the partitions of rainfall into surface runoff, infiltration and evapotranspiration. There are many different soil moisture accounting schemes available: In situ probes are sparsely distributed and their moisture measurements have limited spatial validity because of natural soil heterogeneity. Remotely sensed microwave brightness temperatures can give estimates of soil moisture to a limited depth but there are problems with retrieval below vegetation, so soil and vegetation models have to be used. All methods demand sophisticated measurements and some soil models and a time drifting problem can create large discrepancies between the actual soil moisture and the actual ones. In this paper, a method based on the river flow measurement is explored, which has a potential to be used in real time flood forecasting systems. The research is carried out over a heavily instrumented experimental catchment in southwest of England, Brue river.

The River Brue catchment in Somerset, south-west England, drains an area of 135.2 sq. km to its river gauging station at Lovington. The catchment is predominantly rural and of modest relief, with spring-fed headwaters rising in the Mendip Hills and Salisbury Plain. Clays, sands and oolites give rise to a responsive flow regime.

There are various ways to describe the wetness of a catchment, e.g., API and SMD. In this paper, SMD (Soil Moisture Deficit) is adopted, which represents the amount of water required to restore soil to its field capacity.

There are three flows available for linking with catchment SMD: total flow, baseflow and direct runoff. Total flow and direct runoff are less linked with SMD. It is known that the recession curve dominated by ground water can normally be approximated as $Q_t = kW$, where W is the free water content in the soil, so it is possible to link the baseflow with free water content in the soil. It would be very useful if the free water content could be linked with SMD, albeit SMD is much more difficult to estimate. This is because when SMD is very large (i.e., very dry catchment), a small amount of precipitation could increase the soil water content, but not enough to generate runoff (either direct or ground runoff), hence no change could be observed from the baseflow measurement. Despite of the difficulties involved, this section is set to explore the link between baseflow and SMD.

Fig. 1 presents a scatter plot of baseflow and SMD from 1994-2000 (except 1998 due to missing data points) over Brue catchment. A clear pattern can be observed from this figure and envelope curve can be drawn over the data points (the red line fits quite well to the top of SMD values). This is quite useful in predicting the top SMD threshold from the baseflow. Basically, given any baseflow value, it is possible to derive the maximum SMD value from that baseflow. The exact SMD cannot be decided since the lower threshold is zero. However, the gaps between the maximum and minimum threshold decreases with baseflow value. It can be safely concluded that when baseflow is over 1mm/day, SMD is almost certain to be around zero.

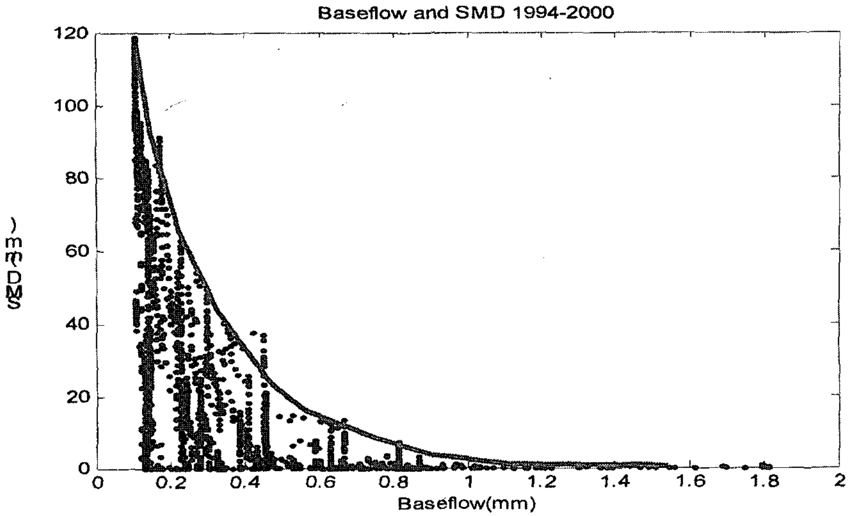

Fig. 1 Baseflow (in daily unit) and SMD

In conclusion, this paper describes an attempt to link the catchment SMD with river baseflow. SMD is derived using FAO Penman-Monteith equation and a modified Xinanjian soil model. An interesting upper bound has been found between SMD and baseflow. This upper bound has a potential to be used in real time flood forecasting when a quick assessment of catchment wetness is needed based on the baseflow data. Further work is needed to narrow down the gap between the upper bound and lower bound.

Key words: Real time flood forecasting, baseflow, catchment wetness, soil moisture deficit