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Preliminary Study on Baseflow Separation at Watersheds in East Java Regions

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Abstract

This research aims to determine the range of parameter value, baseflow index and the appropriate method for *base flow separation.* Seven (7) *recursive-digital-filters (RDF)* and two (2) graphical methods are used for this study. Discharge data from 8 watersheds in the administrative area of UPT PSDA Bondowoso in East Java were used to test the methods. Firstly, each method was calibrated using daily discharge data for each year (annually) to separate baseflow. Then, optimal parameter values are obtained by averaging the annual values. Calibration process produced optimal parameters value for each watershed. Furthermore, validation was performed using optimal parameter values from watershed having complete discharge data to other watersheds. The results show that optimal parameter values from calibrated watershed can be used to separate base flow in other watersheds. Principally, all methods can be used to separate base flow on this region, however three methods (EWMA, Line-Hollick and Local Minimum) perform better than others 6 methods.

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Keywords: baseflow; separation ; digital filter; digital graphic; east java.

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1. Introduction

Hydrograph shows graphical representation of discharge or flow data on the river as function of time. The discharge is plotted as Y-axis and time series data (hourly, daily or monthly basis) is presented in X-axis. Commonly, Hydrograph is used as tool to interpret the response of watershed due to rainfall events. Hydrograph composed of two component, i.e.: quickflow and baseflow. Quickflow represent the rapid response of the river on the watershed caused by direct surface runoff, troughflow and rain event that fall directly to the river body. Baseflow represent the response of the river on the watershed supplied by groundwater flow and other type of flow that enter more slowly to the river streams, as defined by Hall (1986, 1971). Understanding and counting the contribution of these two components is essential for water resources management on the watershed (Brodie and Hostetler, 2007). In tropical region, the contribution of these two components may be significantly different between rainy and dry seasons. Quickflow contribute more dominant during the rainy or wet seasons. Contrary, during the dry season where no or less rainfall on the watersheds, the stream flow are significantly dominated by baseflow contribution to the river.

The quickflow is important to be considered when the objectives of water resources management are to collect, to store and to maintain the volume of water (e.g.: supply of reservoir, paddy irrigation, etc.). For disaster mitigation purposes the prediction of quickflow is also important to anticipate the potential discharge generated by flood event. However, during the dry seasons, majority of rivers in East Java are supplied only by baseflow. Furthermore, during the dry seasons, baseflow contribution are generally less than the demand of flows (for: residential, irrigation, industrial use, etc...). The lack of water supply during the dry season is more and more important problems to be solved during the last decades.

Debit or stream flow that usually observed on the river is actually composed by these two components (quickflow and baseflow). Practically, it is difficult to identify the portion of each component from measured discharge. However, some methods have been developed in order to interpret the portion and contribution of baseflow to river streams.

1.1. Baseflow separation methods from hydrograph

Analysis of baseflow component from hydrograph was reported since Boussinesq (1904), developed a theory from his empirical experience. After that, some related works are developed as published by Maillet (1905) and Horton (1933). Furthermore, literature reviews concern with the development of methodology for baseflow analyses are reported by Hall (1968; 1971), Nathan and McMahon (1990ab), Tallaksen (1995), Smakhtin (2001ab), Brodie and Hostetler (2007), Murphy et al.(2009) and Gonzales et al.(2009). Those examples of works and literature reviews show the development of divers' methodologies for baseflow analysis. Now, more practical methods based on digital filter and digital graphic separation are also developed (Gregor, 2010, 2012). These methods are more practice and more simple to be implemented in developing countries and on others watersheds worldwide.

1.2.1 Recursive digital filter (RDF)

The mechanism of how RDF work is similar to the method used on signal or in frequency analysis. In hydrograph analysis, the filter is use to separate the quickflow component that similar to high frequency signal and the baseflow component that analog to low frequency signal. The process is repetitive for the whole periods of record.

Some RDF algorithms have been developed and can be found, for example on the work of Pettyjohn and Henning (1979), Nathan dan McMahon (1990ab), Grayson et al. (1996), Chapman and Maxwell (1996), Chapman (1999), Furey and Gupta (2001), Tallaksen and Van Lannen (2004), and Eckhardt (2005, 2008). Detailed review of existing method for baseflow analysis (Including RDF methods) are reported by: Brodie and Hostetler (2007) and Murphy et al. (2009). Furthermore, Gregor (2010, 2012) developed practical tool named HydrOffice (http://hydrooffice.org) that serve baseflow separation easily conducted.

Table 1. Six RDF methods used for this study (Gregor, 2010, 2012)