Runoff estimations in a three-part disaggregated flow duration curve

○ Fukushima University Non-member Chris Leong
Fukushima University Member Yoshiyuki Yokoo

1. Introduction

This study investigates the potential use of simple hydrologic model unification to estimate runoff in a three-part disaggregated flow duration curve (FDC). The study has a future goal of contributing towards the aim of predictions in ungauged catchments particularly in islands in the humid tropics and isolating island hydrologic studies from continental methods. The FDC can be an initial application as it is a simple and easy to use hydrologic tool that has provided valuable insight into hydrological nature of catchments. Sivapalan (2003) mentioned that the Earths land surface is still poorly gauged or ungauged especially in many developing countries and stated as fact that in these areas the greatest human impacts are occurring. Interestingly, majority of island nations are developing countries with inadequate hydrologic data (Falkland 2002), therefore the study uses the Hawaiian Islands (Figure 1) to provide insight and be a representative of islands with the same hydrologic nature.

2. Method

The study disaggregates the FDC into high, middle and low flow sections and using theoretical literature and knowledge about process controls for each section; uses simple hydrologic tools without complex calibration in an attempt to make proper runoff estimations. The disaggregated sections of the FDC curve have a 20% overlapping range to account for variability of catchments. The top section as hydrologic literatures suggest is a section that is susceptible to high flows or flooding thus in this study the Curve Number method (CN) is used. The method is widely regarded in storm-runoff studies and is simple and easy to use. The middle section used the mean monthly flow (MMF). The MMF is possibly one of the simplest hydrologic tools due its development in global hydrology initiative. The low flow section of the FDC differentiates between wet and dry catchments because of the difference in shapes of the curve at the low ends of the FDC. The low flow sections uses a combination of methods such as hydrograph separation, linear storage estimation and a process based tank model developed by Yokoo *et al.*, (2017). After reviewing the results, the low flow section used a combination of climatic indices like aridity and precipitation index in a generalized regression analysis approach.

3. Results

The results for the top section showed that the CN method is highly effective within the 10% exceedance probability (EP) range of the FDC regardless whether the catchment is dry or wet (Figure 2). In the figure, the estimated flow (CN estimation) only tends to depart from the observed flow (q_{obs}) after 10% EP, once again supporting hydrologic literature of the use of the CN method for estimating high flows. For the middle section, the result in Figure 3 show the mean monthly flow (q_{mmf}) or the tank model estimation (q_{ss}) been comparable to the observed flow; can be used for estimations in wet catchments and but not dry ones. Towards the initiative of using simplistic models, it is advisable to use the MMF rather than the process based tank model. Lastly, for the low flow section, the tank model or the MMF was able to make proper estimations in wet catchments as seen in the tail end of Figure 3 but not in dry catchments. Reviewing the tank model processes and characteristics of dry catchments, an alternative climate indices approach was used such as aridity index (*AI*) and precipitation index (*PI*). In Figure 4 the estimation by *PI* (q_{PI}) was better than estimation by *AI* (q_{AI}) suggesting that climate is a dominant control of low flows in dry catchments.

Keywords Disaggregated, flow duration curve, runoff estimation, low flow
Address 1 Kanayagawa, Fukushima-city, Fukushma 960-1296, Japan, Phone: 024-548-8296

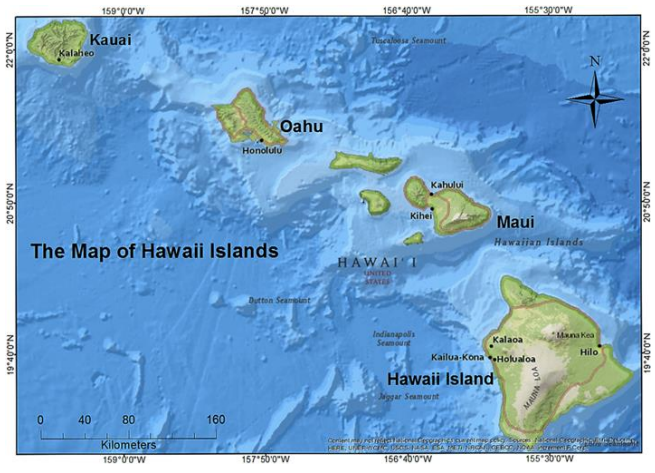

Fig.1 The map of Hawaiian Islands

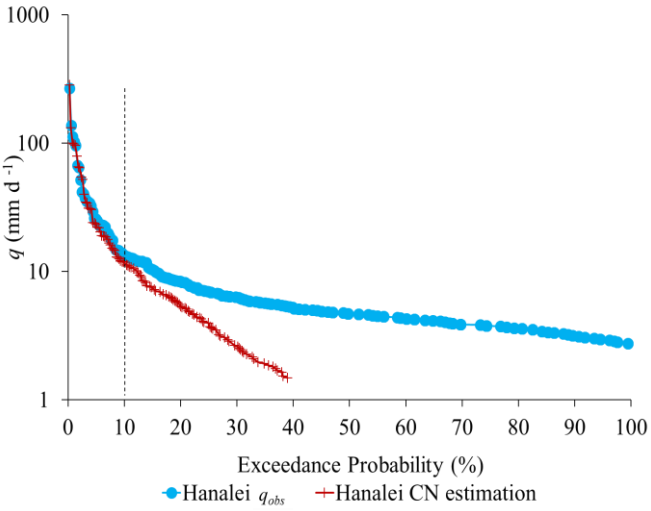

Fig.2 The Curve Number Method results for the top section

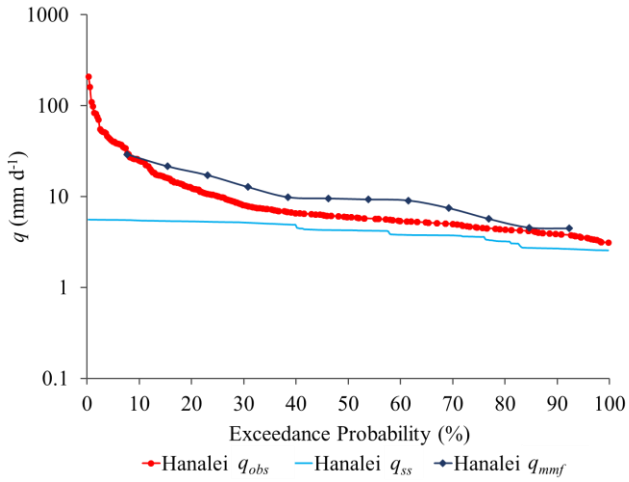

Fig.3 The mean monthly flow results and tank model for the middle and low sections of perennial catchments

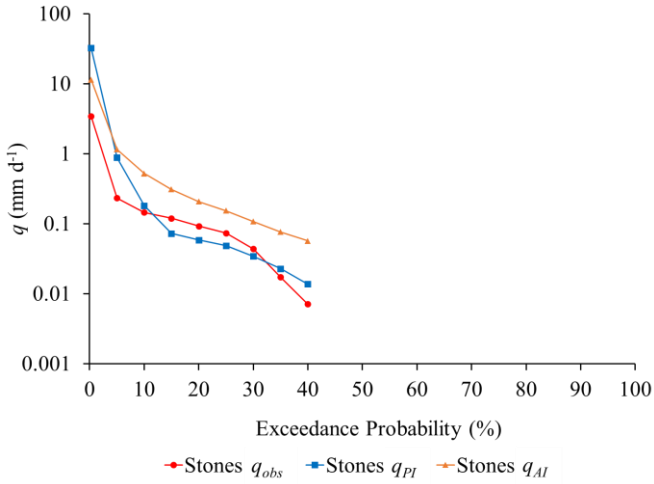

Fig.4 The climate indices results for the middle and low sections of ephemeral catchments

Acknowledgments

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