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A Brief Survey of Regionalization Modeling; A Bonus from Gauged to Ungauged Basins

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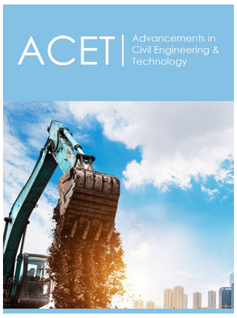
ISSN: 2639-0574



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Submission: July 13, 2019

Published: July 29, 2019

Volume 3 - Issue 4

How to cite this article: Mehdi Sheikh G, Shabnam N. A Brief Survey of Regionalization Modeling; A Bonus from Gauged to Ungauged Basins. Adv Civil Eng Tech. 3(4). ACET.000566.2019.
DOI: 10.31031/ACET.2019.03.000566

Introduction

Runoff-rainfall models (r-r) have been widely used to manage water resources during past decades. One of the most important upfront hydrological issues, certainly in r-r prediction, is adopting the best calibration method [1]. Regarding the importance of calibration procedure in hydrological modeling, various types of methods and approaches have been practiced optimizing parameter values from manual and trial-error-based style to entirely automated, heuristic and sophisticated approaches. Automatic calibration approaches usually take advantage of modern search processes and algorithms to fit residual errors among observed and simulated data (using objective functions) to optimize parameter values [2]. In terms of hydrological modeling, particularly distributed models, changes in spatial characteristics of watersheds and resulting processes, are considered explicitly [3]. These types of models are fundamentally designed to bear various sorts of flow information and watershed attributes to model streamflow accurately and timely (i.e. Big Data Machine Learning [4]).

These models are dispersedly used in flood and discharge prediction of inoperative sites concerning their long runtime and high volume of input data [3,5]. In contrast, there is a particular group of models so called “conceptual models” which conceive hydrological process at all and retrieve hydrological parameters through calibration process. These sorts of models are mainly utilized in ungauged watersheds whose temporal climatological records are dominantly unqualified [6]. Conceptual methods are initially founded on the black-box logic [7].

All of the methods that enable researchers to transform hydrological information (from donor watershed to recipient target), are considered as regionalization analysis series. Regionalization is a broadly appealed process parallel to calibration, with the advantage of limitless application throughout watersheds [8]. Due to the process, regionalization can simply be implemented by establishing an empirical relationship between dependent (flow components or optimized parameters of hydrological models) and independent variables (ecological factors). In term of this, general accuracy of regionalization analysis is mainly a function of input data and methods used (throughout the process). Regionalization is generally planned to apply in ungauged watersheds via two main approaches including flow-based and parameter-based [9,10]. Flow-based regionalization bears flow components such as sediment discharge fluctuation curve, maximum observed flood discharge, prolapsed and peak times of flood durations, flood duration curve parameters, base, peak and mean annual flows. On the other hand parameter-based approach considers slope, watershed area, percentage of land-use and landcover, elevation, length of main river, drainage density, topographic index, soil and bedrock classes, electrical conductivity and porosity, solar extra radiation, temperature and precipitation, and landscape ecological metrics [8,9,11,12].

Having reviewed the literature, featured an above average performance for structural similarity [13-15] and Parametric Regression [16-18], while Averaging [19,20] and Spatial

Proximity [21,22] have shown an acceptable result. The most important issue about regional calibration is the necessity of scenario planning. Accordingly, regional calibration method was effectively employed through the following studies [23-29]. Additionally, watershed numbers (as an iteration unit) should be deeply pondered. In general, modeling performance is getting promoted in line with the increasing number of watersheds. Albeit, inaccurate gauging statistics lead modeling efficiency to downtrend [30].

Furthermore, model type and number of applicable parameters can also be taken into consideration. Following the Parajka et al. [30] and He et al. [8], modeling performance was reversely correlated by the number of parameters. Similarly, such a phenomenon is expectable in models with a large number of parameters (usually more than 15 parameters). Additionally, Synergy effects of number of parameters, watershed area and watershed multiplicity, climate and regionalization method are impressive issues that should be strategically involved in the modeling process in order to make appropriate decisions and applied achievements. For instance, the similarity and spatial proximity methods have shown a higher performance in comparison with regionalization methods (in particular with the Averaging) in the second level tropical watersheds [30].

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