Received: 4 August 2020 | Revised: 5 May 2021 | Accepted: 6 May 2021
DOI: 10.1002/hyp.14209

RESEARCH ARTICLE

WILEY

Do mixing models with different input requirement yield similar streamflow source contributions? Case study: A tropical montane catchment

Jorge Ramón[1] | Alicia Correa[2,3] | Edison Timbe[1] | Giovanny M. Mosquera[1,4,5] | Enma Mora[1] | Patricio Crespo[1]

[1]Departamento de Recursos Hídricos y Ciencias Ambientales, Facultad de Ingeniería & Facultad de Ciencias Agropecuarias, Universidad de Cuenca, Cuenca, Ecuador

[2]Centre for International Development and Environmental Research (ZEU), Justus Liebig University Giessen, Giessen, Germany

[3]Department of Geography and Water and Global Change Observatory, University of Costa Rica, San José, Costa Rica

[4]Instituto Biósfera, Universidad San Francisco de Quito USFQ, Diego de Robles y Vía Interoceánica, Quito, Ecuador

[5]Institute for Landscape Ecology and Resources Management, Justus Liebig University Giessen, Giessen, Germany

Correspondence
Patricio Crespo, Departamento de Recursos Hídricos y Ciencias Ambientales, Facultad de Ingeniería & Facultad de Ciencias Agropecuarias, Universidad de Cuenca, Cuenca, Ecuador.
Email: patricio.crespo@ucuenca.edu.ec

Funding information
Deutsche Forschungsgemeinschaft, Grant/Award Numbers: BR2238/ 14-2, BR 2238/31-1, WI4995/2-1; DIUC, Universidad de cuenca; International Atomic Energy Agency, Grant/Award Number: 22005; Secretaría de Educación Superior, Ciencia, Tecnología e Innovación

Abstract

Hydrogeochemical based mixing models have been successfully used to investigate the composition and source identification of streamflow. The applicability of these models is limited due to the high costs associated with data collection and the hydrogeochemical analysis of water samples. Fortunately, a variety of mixing models exist, requiring different amount of data as input, and in data scarce regions it is likely that preference will be given to models with the lowest requirement of input data. An unanswered question is if models with high or low input requirement are equally accurate. To this end, the performance of two mixing models with different input requirement, the mixing model analysis (MMA) and the end-member mixing analysis (EMMA), were verified on a tropical montane headwater catchment (21.7 km^2) in the Ecuadorian Andes. Nineteen hydrogeochemical tracers were measured on water samples collected weekly during 3 years in streamflow and eight potential water sources or end-members (precipitation, lake water, soil water from different horizons and springs). Results based on 6 conservative tracers, revealed that EMMA (using all tracers) and MMA (using pair-combinations out of the 6 conservative ones), identified the same end-members: rainfall, soil water and spring water., as well as, similar contribution fractions to streamflow from rainfall 21.9% and 21.4%, soil water 52.7% and 52.3%, and spring water 26.1% and 28.7%, respectively. Our findings show that a hydrogeochemical mixing model requiring a few tracers can provide similar outcomes than models demanding more tracers as input data. This underlines the value of a preliminary detailed hydrogeochemical characterization as basis to derive the most cost-efficient monitoring strategy.

KEYWORDS
headwater catchment, mixing models, streamflow, tracers, tropical montane Páramo

1 | INTRODUCTION

As compared to traditional hydrometric measurements such as rainfall, soil water content and streamflow, a limited amount of geochemical tracers collected over a short time span permits a better understanding of the hydrological functioning of a catchment (Crespo et al., 2012; Mosquera, Célleri, et al., 2016; Petelet-Giraud et al., 2016). Tracers are commonly used in hydrograph separation

