# Document details





Environmental Earth Sciences
Volume 78, Issue 11, 1 June 2019, Article number 340

## Altitudinal and temporal evapotranspiration dynamics via remote sensing and vegetation index-based modelling over a scarce-monitored, high-altitudinal Andean páramo ecosystem of Southern Ecuador (Article)

Ramón-Reinozo, M., Ballari, D., Cabrera, J.J., Crespo, P., Carrillo-Rojas, G.

View additional authors

Save all to author list

[a]Departamento de Recursos Hídricos y Ciencias Ambientales, Facultad de Ingeniería, Facultad de Ciencias Químicas, Facultad de Ciencias Agropecuarias, Universidad de Cuenca, Ecocampus Balzay, Cuenca, 010203, Ecuador
[b]Facultad de Ciencia y Tecnología, Instituto de Estudios de Régimen Seccional del Ecuador, Universidad del Azuay, Av. 24 de Mayo s/n, Cuenca, 010204, Ecuador
[c]Laboratory for Climatology and Remote Sensing, Faculty of Geography, Philipps-Universität Marburg, Deutschhausstr. 12, Marburg, 35032, Germany

View additional affiliations

## Abstract

In the tropical Andes, the páramo ecosystem is known as water towers and the main water supplier for the cities of the Andean region. Nevertheless, considering that evapotranspiration (ET) is the major water loss and the lack of in situ evapotranspiration measurements in high altitudinal páramo ecosystems, ET dynamics on the hydrological regulation remains largely unexplored. Therefore, to close this gap, we focused on a remote sensing approach. This study addressed the altitudinal and temporal dynamics of actual evapotranspiration using a crop coefficient based on a Vegetation Index (VI) model. Enhanced Vegetation Index (EVI), Normalized Difference Vegetation Index (NDVI) and Soil-Adjusted Vegetation Index (SAVI) retrieved from Landsat imagery were evaluated. Four remote sensing images and ground-level meteorological data for a 10-month period were used to create ET maps from each VI. A cubic spline interpolation was used to obtain daily ET time series between two satellite overpass dates. Aggregated monthly values were used to validate against ET calculated from water balance. Results revealed that EVI-based ET outperformed the other VI-based ET. The results showed 30% of subestimation (Pbias%) in relation to the water balance. For upgraded results, an extended satellite images time series and a fine calibration are needed. Regarding the altitudinal variability, ET exhibited a strong dependence on land cover characteristics. Our work provides a plausible method to estimate ET in páramo ecosystems in the absence of ET measurements and with a scarcity of clear sky images, further evaluation is necessary to improve ET estimations using remote sensing in the future. 

## SciVal Topic Prominence

Topic: Evapotranspiration | Energy balance | Evaporative fraction

Prominence percentile: 98.195

## Author keywords

Crop coefficient | Ecuador | Evapotranspiration | Páramo | Remote sensing

## Indexed keywords

Engineering controlled terms: Crops | Dynamics | Ecosystems | Evapotranspiration | Image enhancement | Interpolation | Meteorology | Time series | Vegetation | Water towers

Engineering uncontrolled terms

Actual evapotranspiration | Crop coefficient | Cubic-spline interpolation | Ecuador | Enhanced vegetation index | Normalized difference vegetation index | Remote sensing approaches | Remote sensing images

Engineering main heading:

Remote sensing

GEOBASE Subject Index:

altitude | evapotranspiration | in situ measurement | Landsat | modeling | monitoring | paramo | remote sensing | satellite imagery | temporal variation | vegetation index | water budget

Regional Index:

Andes | Ecuador

## Funding details

1

Acknowledgements This manuscript is an outcome of the University of Cuenca's Master Program in Ecohydrology. This work was funded by the Project XIII–Conc: "Estudio Comparativo de Métodos de Esti-mación de Evapotranspiración Actual en Suelos Húmedos de una Micro cuenca de Páramo Andino" of the Research Office of the University of Cuenca (DIUC). We are grateful for the economic support. We thank the Municipal Company of Telecommunications, Drinking Water, Sewage and Sanitation of Cuenca (ETAPA-EP) and the Ecuadorian Secretary of Higher Education, Science, Technology and Innovation for their cooperation. We thank the Ministry of Environment of Ecuador (MAE) for the research permissions. We thank Sarah Schob and Dr. David Windhorst for providing us the Quinoas land-cover map through the project DFG PAK 825/1 subproject C7 (BR 2238/14-1), and we thank the Laboratory for Climatology and Remote Sensing, Philipps-Universität Marburg (through the project DFG PAK823–825 subproject C6 (BE1780/38–1) which supported our study in knowledge transfer. Finally, we are grateful to technical staff of the Department of Water Resources and Environmental Sciences of the University of Cuenca who contributed to the stream flow and meteorological monitoring.

**ISSN:** 18666280
**DOI:** 10.1007/s12665-019-8337-6
**Source Type:** Journal
**Document Type:** Article
**Original language:** English
**Publisher:** Springer Verlag

Ramón-Reinozo, M.; Departamento de Recursos Hídricos y Ciencias Ambientales, Facultad de Ingeniería, Facultad de Ciencias Químicas, Facultad de Ciencias Agropecuarias, Universidad de Cuenca, Ecocampus Balzay, Cuenca, Ecuador;