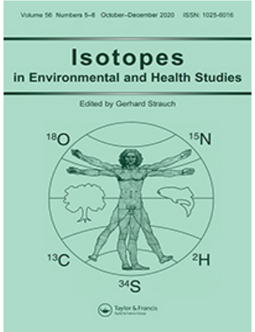

Isotopes in Environmental and Health Studies

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/gieh20

Environmental isotope applications in Latin America and the Caribbean region

David X. Soto , Ricardo Sánchez-Murillo , Lucía Ortega , Orlando Mauricio Quiroz Londoño , Luis J. Araguás-Araguás & Veridiana Martins

ISOTOPES IN ENVIRONMENTAL AND HEALTH STUDIES
2020, VOL. 56, NOS. 5–6, 387–390
https://doi.org/10.1080/10256016.2020.1839448

Taylor & Francis
Taylor & Francis Group

EDITORIAL

Environmental isotope applications in Latin America and the Caribbean region

This Special Issue illustrates the use of environmental isotopes in studying and assessing hydrogeological and ecohydrological issues in the Latin America and the Caribbean (LAC) region. The issue includes twenty selected papers, which have been peer-reviewed in *Isotopes in Environmental and Health Studies*. Although the LAC region concentrates a third of the world's freshwater resources [1], access to safe water supplies and sanitation remains unevenly distributed, with water scarcity affecting most arid and semiarid areas and serious water quality issues across the region [2]. About 82% of the LAC population lives in urban centres, including some megacities, creating major challenges to water authorities [3]. Water security is often compromised due to a fast-growing water demand near urban centres (i.e. domestic supply, irrigation and industrial uses) along with the expected impacts of climate change [4] on both water availability and quality [5–7]. In many parts of the LAC region, groundwater resources have become the main or the only source of water to cover basic human needs and the maintenance of ecosystems [8–10]. This rapid increase of water demand is generally translated into intensive and unsustainable exploitation of water resources, having a profound impact on local hydrological cycles. In order to assess the availability of local resources for the near future and adopt sustainable management practices, sound and precise hydrological information is required.

Stable (^{2}H, ^{13}C, ^{15}N, ^{18}O, ^{87}Sr) and radioactive (^{3}H, ^{7}Be, ^{14}C, ^{210}Pb, ^{222}Rn) environmental isotopes can provide unique and valuable information required for the assessment and comprehensive management of water resources and for understanding the complex interactions between terrestrial ecosystems (i.e. soil, vegetation) and the hydrological cycle. Isotope hydrology tools and methods have been used to characterise both surface and ground water systems, study recharge processes from rainfall generation to infiltration, coastal aquifers, major lakes and river basins as well as in assessing lake dynamics, geothermal fields, dam leakage problems, and evapotranspiration partitioning [11]. However, the incorporation of these applications in LAC has not been fully implemented yet. To date, there is a relatively small number of case studies published from a limited number of institutes and universities, often through the assistance and support provided since the 1980s by the International Atomic Energy Agency (IAEA) or through bilateral cooperation with other international agencies.

The pressing need in recent years to better describe and understand our natural systems, coupled with the easier access to analytical instrumentation [12], has resulted in the establishment and consolidation of many research groups in the LAC region using environmental isotopes to study hydrological and ecological systems. Therefore, the region has made steady progress over the last years to train a new generation of experts in hydrology and ecology with courses and workshops on the use of environmental isotopes at the university level. Despite these advances, the dynamics and ecosystem functioning within the hydrological cycle in the region remain poorly understood.

This special issue presents a selection of papers covering a wide array of applications based on the use of environmental isotopes to gain novel information from understudied basins in the LAC region, yet they store one of the largest water and natural resources in the world. The issue comprises studies from Argentina, Brazil, Chile, Costa Rica, Cuba, Martinique, and Mexico. Topic areas presented in the issue are divided into two main groups: groundwater systems (GW) and (eco)-hydrology (EH) issues, with inter-connections and some multidisciplinary (MD) areas:

- *Recharge mechanisms* (GW): understanding of recharge processes from rainfall generation to deep percolation under exploitation scenarios [13–15].
- *Headwaters dependent systems* (GW): analysis of the relevance of high elevation recharge to supply lowland urban areas and ecosystems as well as groundwater to surface connectivity [15–18].
- *Groundwater age and conceptual models* (GW): dating of fossil groundwater systems and development or enhancement of conceptual groundwater flow models in large aquifers [13,19–21].
- *Transboundary aquifers* (GW): groundwater flow complexities across large continental aquifer areas [21].
- *Hydrological processes* (EH): Contributions that studied the water sources and pathways within the hydrological cycle, from precipitation [22] to surface and groundwater [23,24], including drinking water resources [25] under different hydrological conditions. Some of these included catchment-scale conceptual hydrogeological models.
- *Atmospheric processes* (EH): Stable isotope techniques to investigate the local sources and atmospheric conditions that control the spatio-temporal distribution of precipitation and greenhouse gases [22,26].
- *Land–water interactions* (EH): Vegetation cover aids to protect soil surface from erosion, whose rates can be estimated by using radioactive isotope (^{7}Be) techniques [27]. The transport and pathways of organic carbon from areas of production to deposition zones within watersheds were determined in estuaries [28].
- *Water quality* (MD): assessments of temporal and spatial trends in groundwater and surface water pollution as well as tracking contaminants/solutes origin [15,16,29,30]. Challenges to identify anthropogenic nutrient loading in coastal areas have been recognised [31].
- *Measurement traceability* (MD): The number of papers using isotope applications increases every year, which requires good laboratory protocols and analytical performance to produce high quality data and results at the regional scale [12].

The overall objective of this issue is to promote a greater interest among water managers and researchers in the LAC region on the use of environmental isotopes for water resource assessment studies aimed at a better understanding of local water resources and their interactions with land and atmosphere.

References

[1] Bonilla Valverde JP, Stefan C, Palma Nava A, et al. Inventory of managed aquifer recharge schemes in Latin America and the Caribbean. Sustain. Water Resour Manag. 2018;4(2):163–178.
[2] Hernández-Padilla F, Margni M, Noyola A, et al. Assessing wastewater treatment in Latin America and the Caribbean: Enhancing life cycle assessment interpretation by regionalization and impact assessment sensibility. J Clean Prod. 2017;142:2140–2153.
[3] Hommes L, Boelens R, Bleeker S, et al. Water governmentalities: The shaping of hydrosocial territories, water transfers and rural–urban subjects in Latin America. Environ Plan E. 2019;3(2):399–422.
[4] Reyer CPO, Adams S, Albrecht T, et al. Climate change impacts in Latin America and the Caribbean and their implications for development. Reg Environ Change. 2017;17(6):1601–1621.
[5] Mahlknecht J, González-Bravo R. Measuring the water-energy-food nexus: the case of Latin America and the Caribbean region. Energy Procedia. 2018;153:169–173.

[6] Pichs-Madruga R. Key socio-economic drivers for environmental change in Latin America and the Caribbean since 1960: trends, interactions and impacts. In: Ninan KN, editor. Environmental assessments. Cheltenham, GL: Edward Elgar Publishing; 2020. p. 179–199.
[7] Peña-Guzmán C, Ulloa-Sánchez S, Mora K, et al. Emerging pollutants in the urban water cycle in Latin America: A review of the current literature. J Environ Manage. 2019;237:408–423.
[8] Getirana A. Extreme water deficit in Brazil detected from space. J Hydrometeorol. 2016;17(2):591–599.
[9] Donoso G, Lictevout E, Rinaudo JD, et al. Groundwater management lessons from Chile. In: Rinaudo JD, Holley C, Barnett S, editor. Sustainable groundwater management. Cham, ZH: Springer Nature; 2020. p. 481–509.
[10] Castellazzi P, Martel R, Rivera A, et al. Groundwater depletion in Central Mexico: Use of GRACE and InSAR to support water resources management. Water Resour Res. 2016;52(8):5985–6003.
[11] Bowen GJ, Cai Z, Fiorella RP, et al. Isotopes in the water cycle: regional-to global-scale patterns and applications. Annu Rev Earth Planet Sci. 2019;47:453–479.
[12] Terzer-Wassmuth S, Ortega L, Araguás-Araguás L, et al. The first IAEA inter-laboratory comparison exercise in Latin America and the Caribbean for stable isotope analyses of water samples. Isot Environ Health Stud. 2020;56, this issue.
[13] Blarasin M, Cabrera A, Matiatos I, et al. Application of isotope techniques to enhance the conceptual hydrogeological model and to assess groundwater sustainability in the Pampean plain in Córdoba, Argentina. Isot Environ Health Stud. 2020;56, this issue.
[14] Kreis M, Taupin J-D, Patris N, et al. Isotopic characterisation and dating of groundwater recharge mechanisms in crystalline fractured aquifers: example of the semi-arid Banabuiú watershed (Brazil). Isot Environ Health Stud. 2020;56, this issue.
[15] Pérez-Quezadas J, Cortés-Silva A, Morales-Casique E, et al. Identifying groundwater end members by spatio-temporal isotopic and hydrogeochemical records. Isot Environ Health Stud. 2020;56, this issue.
[16] Madrigal-Solís H, Jiménez-Gavilán P, Vadillo-Pérez I, et al. Application of hydrogeochemistry and isotopic characterization for the assessment of recharge in a volcanic aquifer in the eastern region of central Costa Rica. Isot Environ Health Stud. 2020;56, this issue.
[17] Quiroz Londoño OM, Romanelli A, Martínez DE, et al. Water exchange processes estimation in a temperate shallow lake based on water stable isotope analysis. Isot Environ Health Stud. 2020;56, this issue.
[18] Sileo NR, Dapeña C, Trombotto Liaudat D. Isotopic composition and hydrogeochemistry of a periglacial Andean catchment and its relevance in the knowledge of water resources in mountainous areas. Isot Environ Health Stud. 2020;56, this issue.
[19] Ezaki S, Gastmans D, Iritani MA, et al. Geochemical evolution, residence times and recharge conditions of the multilayered Tubarão aquifer system (State of São Paulo – Brazil) as indicated by hydrochemical, stable isotope and ^{14}C data. Isot Environ Health Stud. 2020;56, this issue.
[20] Glok Galli M, Martínez DE, Vadillo-Pérez I, et al. Multi-isotope (δ^2H, $\delta^{18}O$, $\delta^{13}C$-TDIC, $\delta^{18}O$-TDIC, $^{87}Sr/^{86}Sr$) and hydrochemical study on fractured-karstic and detritic shallow aquifers in the Pampean region, Argentina. Isot Environ Health Stud. 2020;56, this issue.
[21] Vives L, Rodríguez L, Manzano M, et al. Using isotope data to characterize and date groundwater in the southern sector of the Guaraní Aquifer System. Isot Environ Health Stud. 2020;56, this issue.
[22] Martínez DE, Maenza R, Quiroz Londoño OM. Atmospheric constraints on $\delta^{18}O$ and *d*-excess in precipitation at the middle latitude in the southwestern Atlantic region. Isot Environ Health Stud. 2020;56, this issue.
[23] Crespo SA, Fernandoy F, Cara L, et al. First snow, glacier and groundwater contribution quantification in the upper Mendoza River basin using stable water isotopes. Isot Environ Health Stud. 2020;56, this issue.
[24] Poca M, Nosetto M, Ballesteros S, et al. Isotopic insights on continental water sources and transport in the mountains and plains of Southern South America. Isot Environ Health Stud. 2020;56, this issue.
[25] Sánchez-Murillo R, Esquivel-Hernández G, Birkel C, et al. From mountains to cities: a novel isotope hydrological assessment of a tropical water distribution system. Isot Environ Health Stud. 2020;56, this issue.
[26] Carballo-Chaves K, Villalobos-Forbes M, Esquivel-Hernández G, et al. Isotope composition of carbon dioxide and methane in a tropical urban atmosphere. Isot Environ Health Stud. 2020;56, this issue.
[27] Videla X, Villegas D, Parada AM, et al. Assessment of runoff using ^{7}Be in vineyards in the central valley of Chile. Isot Environ Health Stud. 2020;56, this issue.
[28] Alonso-Hernández CM, Fanelli E, Diaz-Asencio M, et al. Carbon and nitrogen isotopes to distinguish sources of sedimentary organic matter in a Caribbean estuary. Isot Environ Health Stud. 2020;56, this issue.
[29] Arumi J, Escudero M, Aguirre E, et al. Use of environmental isotopes to assess groundwater pollution caused by agricultural activities. Isot Environ Health Stud. 2020;56, this issue.

[30] Gourcy L, Baran N, Arnaud L. Water isotopes and chemical tools for understanding pesticide transfer in a watershed of the volcanic island of Martinique (French West Indies). Isot Environ Health Stud. 2020;56, this issue.

[31] Samper-Villarreal J. Strengths and challenges of $\delta^{15}N$ to identify anthropogenic nutrient loading in coastal systems. Isot Environ Health Stud. 2020;56, this issue.

David X. Soto
UK Centre for Ecology and Hydrology, Lancaster, UK
davidxsoto.mail@gmail.com http://orcid.org/0000-0003-4210-293X

Ricardo Sánchez-Murillo
Universidad Nacional, Heredia, Costa Rica

Lucía Ortega
International Atomic Energy Agency, Vienna, Austria
http://orcid.org/0000-0002-5181-9054

Orlando Mauricio Quiroz Londoño
Universidad Nacional de Mar del Plata, CONICET, Mar de Plata, Argentina

Luis J. Araguás-Araguás
International Atomic Energy Agency, Vienna, Austria

Veridiana Martins
Universidade de São Paulo, São Paulo, Brazil