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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 (^2H , ^{13}C , ^{15}N , ^{18}O , ^{87}Sr) and radioactive (^3H , ^7Be , ^{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 (^7Be) 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.

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