Making the grade

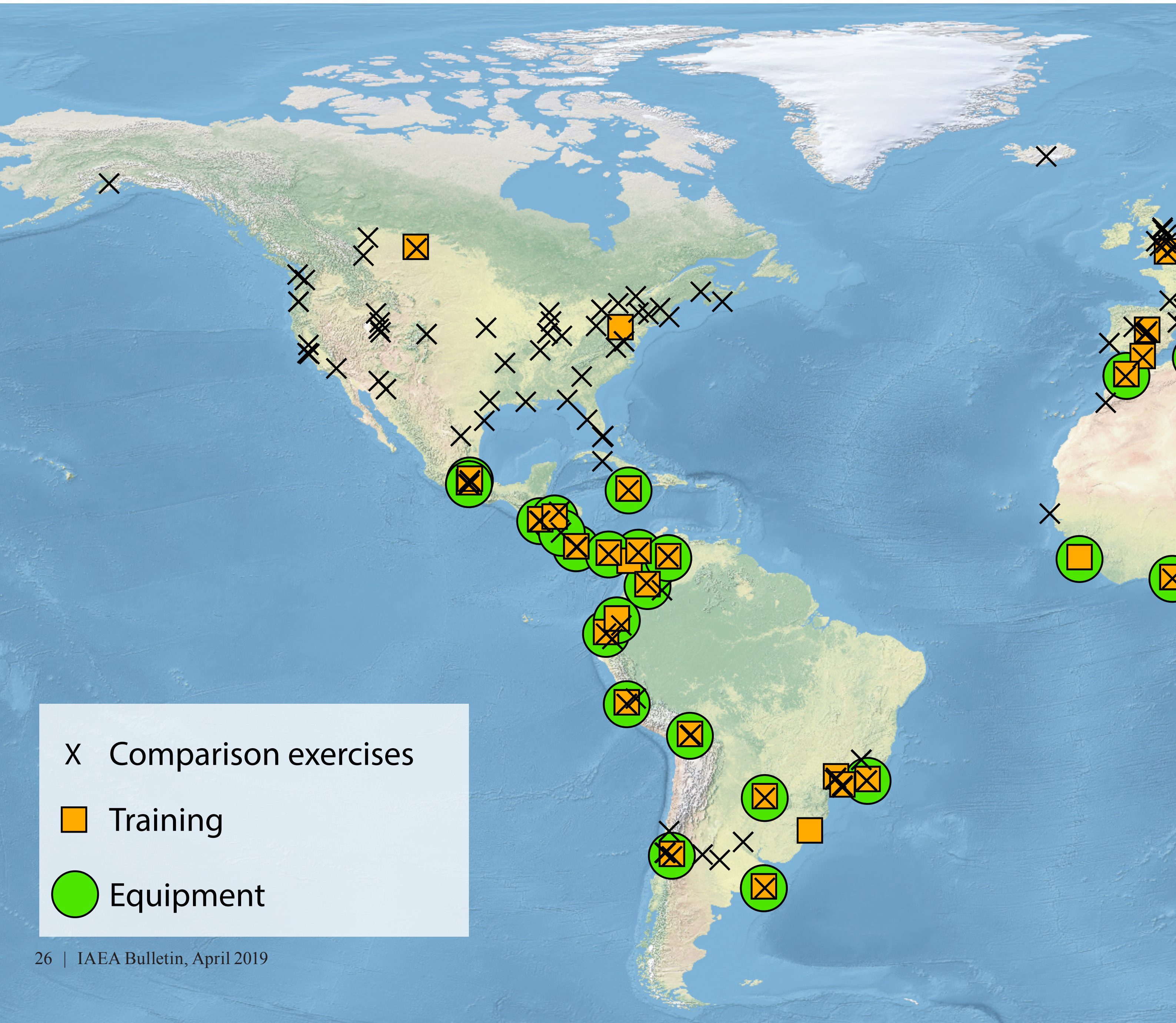
IAEA tests how well laboratories analyse water

By Laura Gil

Excellent, good, questionable or unacceptable: how good is your water chemistry analysis? Scientists can find out through comparison. For the past 30 years, the IAEA has been conducting isotope hydrology interlaboratory comparisons among hundreds of laboratories and has become a global source of isotope hydrology proficiency tests.

"A key aspect in any science is the quality of your measurements," said Luis González Hita, Hydrology Technologist at the Mexican Institute of Water Technology. "This is true for isotope hydrology, too. Guaranteeing that our data are correct and reliable gives us a solid base for convincing policymakers."

Isotope hydrologists are scientists who study water resources using isotopic data. Their studies provide critical information for developing strategies and policies to protect water. Approximately every four years, over



300 isotope hydrology laboratories take part in global interlaboratory comparison proficiency tests organized by the IAEA.

Comparing data with IAEA test samples, which include a wide range of waters from around the world, helps staff in each laboratory detect and improve analytical weaknesses. It helps them ensure they are consistently producing accurate and precise data.

Regular cross-comparisons are ever more relevant today: technology is advancing rapidly, making isotope hydrology methods and instruments cheaper and more accessible. Although these technology changes have their benefits, they lead to a higher risk of error because newcomers to the field often have less advanced training.

"Nowadays, especially with laser-based methods, technology does a lot of the work," González Hita said. "This means that scientists are relying more on methods to do the assessments, but it also means they're relying less on skill sets."

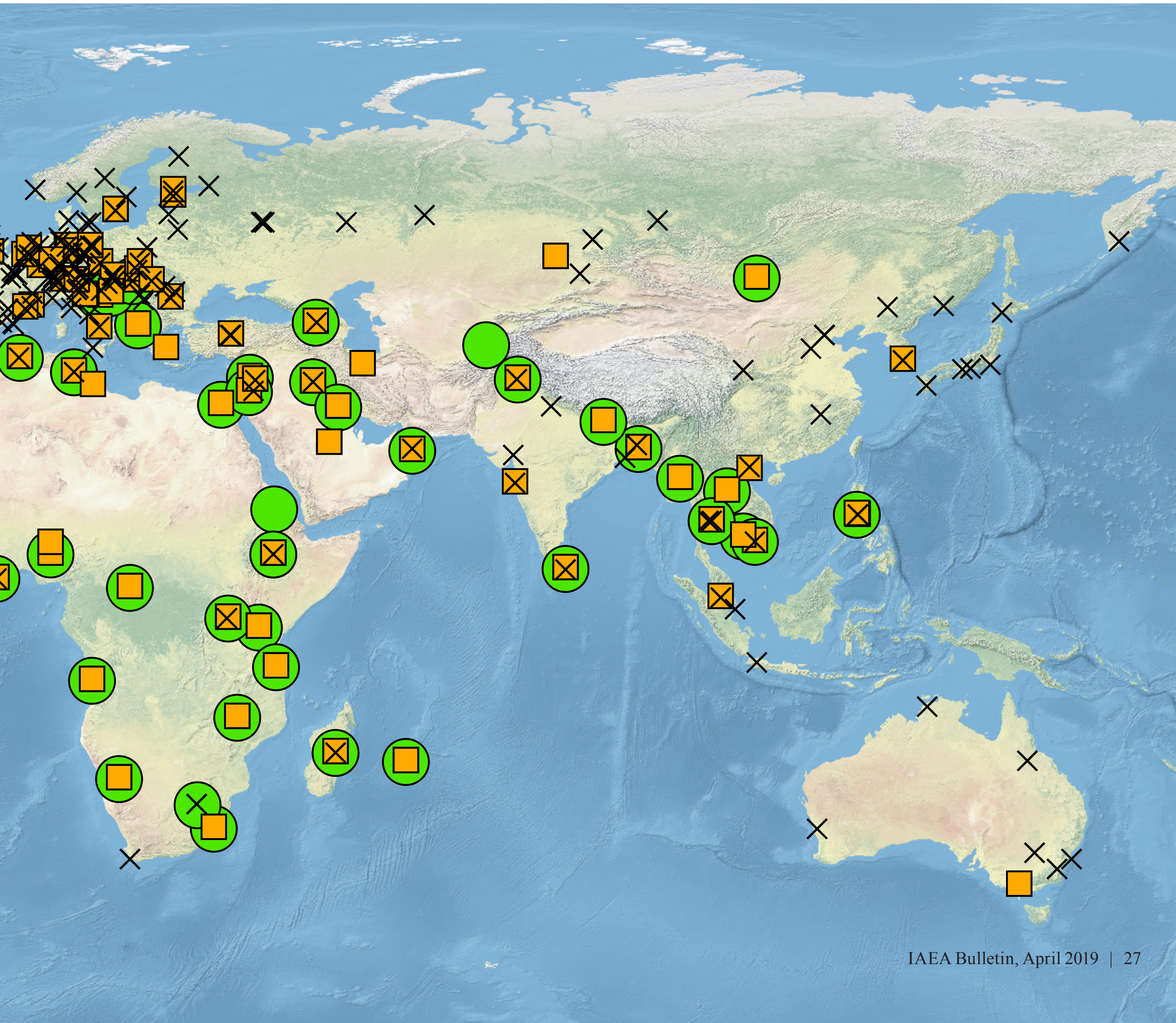
Seeking excellence

There are two types of interlaboratory comparison projects. One is the Water Isotope Interlaboratory Comparison (WICO), which tests laboratories' ability to conduct measurements of deuterium (^2H) and oxygen-18 (^{18}O) in water samples. Measuring these isotopes accurately allows scientists to determine the age and origin of water (read more on page 4).

The other is the International Tritium Intercomparison (TRIC), which checks

The map shows cities that have participated in interlaboratory comparison exercises (WICO & TRIC) since 2016, places where the IAEA has trained experts in isotope hydrology since 2007 and locations where the IAEA has donated isotope laser instruments since 2007 through the IAEA technical cooperation programme.

(Source: IAEA)



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laboratories' ability to measure the natural radioisotope tritium (^3H) in water. Tritium measurements are used to analyse water replenishment rates and to study water younger than 60 years old (see page 4). TRIC checks how precise and correct these measurements are. The most recent TRIC exercise took place in 2018 with a record participation of 90 laboratories.

"The way these interlab comparison projects work is simple," said Leonard Wassenaar, Head of the IAEA Isotope Hydrology Laboratory based in Vienna, Austria. "We prepare and carefully verify water samples here and ship them to each laboratory. They analyse them and send us their results, which we then compare to our IAEA reference values. At the end, we compile the results in a general anonymous report for the scientific community, and in parallel send a detailed report to each lab individually with suggestions and recommendations for improvement."

The reports the IAEA produces after each exercise contain evidence-based recommendations to help laboratories refine their methods and improve their performance. They also help IAEA experts to identify gaps and target further assistance, including training laboratory staff, through the IAEA technical cooperation programme.

Testing vigilance

The largest ever global interlaboratory comparison for stable isotopes was the most recent WICO exercise in 2016 involving 235 laboratories. Its results were published in the *Rapid Communications in Mass Spectrometry* scientific journal in November 2017.

During the WICO 2016 exercise, Wassenaar and his team tried something new.

"We added methanol to one of the water samples to test the laboratories' vigilance in detecting interfering pollutants — without warning them, of course," said Wassenaar. "After finding out that many overlooked this, we came up with a few strategies for them to identify the presence of interfering contaminants in water that could lead to incorrect results."

Most of the laboratories involved in WICO 2016 produced acceptable to excellent results when analysing oxygen isotopes, and about half did when analysing deuterium. But around 5 to 6% had unacceptably poor results, which Wassenaar said could be due to the rapid increase in the number of instruments in labs, such as low-cost lasers, especially among less experienced laboratories.

"We concluded that poor laboratory performance probably resulted from unquantifiable 'known unknowns'," Wassenaar said. "When laboratories appear to be doing everything right but still perform poorly, it could be from mistakes like errors in their Excel processing spreadsheets, or an instrument that is not properly maintained. These are mistakes and human errors that are common but may not be apparent to the laboratory."

These, he added, include knowledge-based or skill-based factors, such as operator experience, basic data processing mistakes, measurement protocol violations, compromised samples or poorly functioning analytical instruments.

Recent studies published in the *Accreditation and Quality Assurance* journal have suggested that human errors can significantly contribute to underperforming geochemical analysis outcomes. The post-WICO 2016 survey of participating laboratories supports the premise that human, technical and instrumental errors are the main drivers for poor water isotope performance.

"Finding errors leads to adjustment. It is important to know where we are producing reliable results, and where not," González Hita said. His laboratory in Mexico scored highly in the latest WICO test. "WICO 2016 allowed us to confirm that we are making good quality analyses. This is also good to know for neighbouring countries, because they can rely on our services and we can share best practices."