



## Verifying the declared origin of timber using stable isotopes and multi-element analysis

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The FLEGT (Forest Law Enforcement Governance and Trade) regulations were introduced in 2003 with the intention of reversing the rate of destruction of the world's forests. One of the European Union's aim is to halt the import of illegally acquired and endangered timber. The timber trade law (regulation (EU) 995/2010) stipulates that importers of tropical timber must be able to identify the origin of timber used in their products, and from the 3rd March 2013, it is a criminal offence to sell illegally sourced timber in the European Union without a FLEGT licence. There are few analytical methods available to determine the declared origin of timber. The current procedure involves checking of shipping documents and visual checks of common timber species for origin identification.

For our project, one hundred timber cores samples of Sapele, Rosewood and Ebony trees were taken from across West Africa and Madagascar. The  $\delta^{2\text{H}}$ ,  $\delta^{13\text{C}}$  and  $\delta^{18\text{O}}$  isotopes of the extracted cellulose were determined by using an elemental analyser coupled to an isotope ratio mass spectrometer (EA-IRMS). Additionally, multi-element profiles of the timber samples were determined by inductively coupled plasma mass spectrometry ICP-MS, to assess the potential for geographical origin discrimination based on the combined profile of stable isotope ratios and multi-element concentrations. Using the multivariate statistical technique of canonical discriminant analysis (CDA), data were processed enabling a cross validation rate of 86.6%.

Twenty elemental variables were selected by canonical discriminant analysis (Mn, Mo, Cr, Sr,  $\delta^{18\text{O}}$ , Na, Se, Ba, Fe, Co, Ln, Ag, B, Ca, Ti, Al, V, As, Pd, and  $\delta^{13\text{C}}$ ), which provided maximum discrimination between the timber samples originating from Ghana, Cameroon, The Congo, The Democratic Republic of Congo (DRC), and Madagascar. Hence, the combination of the methodologies of stable isotope ratio and trace element analysis offers an effective approach to verifying the declared origin of timber.