B126 Using Climate Modeling to Predict the Origin of Seized Cannabis

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After attending this presentation, attendees will appreciate the potential of using climate data to predict the isotopic composition of natural drugs and other natural materials and the use of their spatial distribution for geographical provenancing intelligence.

This presentation will impact the forensic science community by creating awareness that it is possible to use geospatial climatic data to obtain natural drugs' provenance intelligence.

The hydrogen and/or oxygen isotopic composition of many natural biological materials is strongly dependent on the local isotopic composition of groundwater, which in is turn directly related to that of local precipitation. The Hydrogen (H) and Oxygen (O) isotopic composition of precipitation is a function of a number of factors. The cause of different relative abundances of the H and O isotopes in water molecules is the isotopic fractionation during evaporation and condensation. As the contribution of the different masses of the isotopes on the total energy of the water molecule is temperature dependent and more pronounced at lower temperatures, also more fractionation is observed at lower temperatures.

The two main factors that determine the H and O isotopic composition of precipitation at a specific location are the isotopic composition of the surface water in the source region where evaporation took place (which for major air masses is often one of the oceans) and the temperature during precipitation. Both the temperature of the source surface water and that of the air mass during precipitation will correlate with the general geographical latitude where a specific air mass is travelling. As an air mass travels inland and loses moisture through precipitation, the isotopic composition of the residual air mass will be isotopically lighter as it loses the heavier fraction in the precipitation. Often as an air mass travels inland, its altitude will increase, especially over mountainous areas, and as temperature generally drops with altitude, the isotopic composition of the precipitate also changes.

As the mentioned processes are well understood and high-resolution climatic and topographic data are freely available, it is thus possible to create spatial models that predict the isotopic composition of groundwater that is taken up by plants such as cannabis. In order to develop the critical modeling step to link the isotopic composition of groundwater with that of cannabis buds and/or leaves, many samples of cannabis of different climate zones would be required for analysis. As the seizing of cannabis by the police in New Zealand is opportunistic and not in a systematic spatial or temporal manner, it was decided to test the use of blackberry as a proxy for cannabis. Blackberry belongs to the same botanical order of Rosales and is ubiquitous in New Zealand. Blackberry was collected at 130 locations on the North and South Islands. In addition, cannabis samples from four locations at different latitudes were collected by the Institute of Environmental Science and Research (ESR) and New Zealand police for comparison and validation with the blackberry results.

Monthly water isotope data collected from 50+ locations by this group from 2007 to 2010 was combined with climate data from the New Zealand climate research organization (Virtual Climate Station Network-NIWA) to produce a model that predicts the isotopic composition of precipitation on a 5km x 5km scale for the whole of New Zealand. Subsequently, the precipitation isotope data were combined with hydrogen isotope measurements of the collected blackberry leaves and a linear relation was observed. This linear relation in turn allowed for the creation of a prediction model of the H isotope composition in blackberry leaves anywhere in New Zealand.

To validate the use of the blackberry data as a proxy for cannabis, both bulk leaf and compound-specific measurements of the hydrogen isotopic composition of both plants were compared. The initial data shows linear correlations that provide proof of principle but a larger and controlled set of cannabis samples needs to be collected to validate the use of the prediction model throughout the whole of New Zealand. In this presentation, a source apportionment tool will be presented that depicts the statistically most likely source regions for future seized cannabis samples which will provide New Zealand with strategic intelligence as to where to direct resources to detect and destroy illegally grown cannabis.

Cannabis, Climate Modeling, Isotopes