Data Visualization and Normalization of Results From Stable Isotope Analysis

German Torres

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1 Abstract

Stable isotope analysis can be expensive when taking into consideration the pre-treatments necessary to get accurate results. Mathematical corrections are available but can be a problem to apply this to a large dataset. This project will tackle this issue finding a way to do it automatically and visualize the data necessary in a map. This would solve this problem and greatly reduce the time and the money spent in this kind of projects.

2 Background

Isotopes are alternative versions of elements. They have the same properties, however their molecular weight and natural availability differ. Stable isotopes refer to the naturally occurring versions of these elements that do not decay over time. The flux of macro nutrients like Nitrogen and Carbon play a key role in the sustaining of any ecosystem(Pinnegar et al). Stable isotope analysis is a tool that measures the ratios between normal elemental molecules and their stable isotopic version. The analysis can give information about habitat complexity, food-web interactions and nutrient availability.

Although stable isotope analysis provides a novel tool for ecology it also has its drawbacks. One of the main issues in the analysis of organic tissues is the need of pre-treatments like acid treatment and lipid extraction to improve the quality of the readings of a specific element(Mintenback et al 2008). However this proves to be quite expensive in large numbers and also, while it increases the accuracy of the readings for a specific isotope it usually has a negative impact on the readings of the other elements. Mathematical correction for have been proposed to counterbalance these misreadings. Currently there is not any software that would do this correction for someone, this is why a program that corrects the values to be more accurate would be a helpful tool for researchers working in this field.

3 Objectives

As the utilization of Python programming in environmental sciences keeps increasing also new ways to approach a problem are created. The purpose of this project is simple:

- Development of a program which makes a mathematical correction in the carbon isotope values of untreated organic tissue. This would be done utilizing the formula: $\delta^{13}C_{normalized} = \delta^{13}C_{untreated} - 3.32 + 0.99 * C : N$ (Post et al 2007) This could be easily done utilizing a for loop since it is not a complicated formula. So instead of seeing this as an endgame goal it is best to think of it as a part of a puzzle.
- When dealing with data sets it is important to be able to visualize them somehow. Software like R, SPSS and GIS can offer a complete tool-set to do this, however being able to utilize Python to program a way to do this is also an accomplishment on its own. Cartopy and Geopandas libraries will be utilized to make the program to visualize the corrected stable isotope data on a map of the gulf that will show the sampling sites where the tissue was taken.

Figure 1: Example of Cartopy

4 Broader Impacts

This program would be a great tool for scientists that work with stable isotope analysis. Pre-treatments like lipid extraction is time-consuming and can be expensive, this can offer a budget-friendly alternative. The downside to this is that there is a need for better mathematical corrections for different types of isotopes, therefore this program would not be able to cover the need of chemical pre-treatments. Even if this program does not go beyond the scope of this class it may help to bridge the gap between computer science and environmental sciences.

5 Timeline

5.1 Week 1:

start to work on the mathematical formula. Test the loop on different data sets gathered from the Internet and from other published works to confirm the correction works.

- Every numerical input that fulfills specific parameters should be able to generate a result.
- Use pandas to generate data arrays so the results would be easier to work with

5.2 Week 2:

Use cartopy and geopandas to do a map of the gulf of mexico and make a function that automatically plots the data in the map. Research about user interface. beginitemize

- The map should show the sampling sites where the isotopes were taken from. The dots in the sites should visually represent the isotope levels in each site.

5.3 Week 3:

Implement the mathematical correction as a function into the map program. Run some figures and compare the resulting maps to those published before. Start working with user interface elements.

References

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