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Stochastic TOC modeling for East African Rift System Lakes, a possible pre-salt analogous.

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Introduction

In Brazil, one of the key challenges concerning ultra-deepwater exploitation is the complete understanding of the paleoenvironment and its variables that compose Total Organic Content (TOC), in lake systems [1]. Brazilian geoscientists aim for the part of this goal by defining pre-salt sequence as sedimentary rich organic rocks formed in great rift lake systems during Lower Cretaceous Period [2]. According to the uniformitarianism principle, a structural pre-salt analogous is suggested, in this work, from TOC's studies of the East African Rift Lakes [3,4].

Fuzzy systems models are great metaheuristic tools that can enlighten TOC modeling while the lake's function is not known and its variables have a strong statistical dependence [5]. One case is the TOC's predictive modeling problem. In this case, it is possible to simulate over a sequence of different lakes scenarios of accumulation and preservation of the organic carbon before diagenetic processes, generating fundamental information about the potential lacustrine source rocks.

This work aims to validate a direct fuzzy model that predicts the Total Organic Content (TOC) inside Rift Lake Systems. In this sense, we use as a geological analogous to pre-salt Rift System the East African Lakes that have TOC data available and compare two different membership functions[7].

Experimental

For the total organic carbon simulation, we use a data set composed of lake variables such as dissolved oxygen (mg/L), sedimentation rate (cm/kyear), grain size deposit (mm), grain selection(mm), primary productivity (gC/m²/year), lake depth (m), and TOC (%) of five great African lakes known as Lakes Edward, Mobutu, Kivu, Tanganyika, and Victoria.

The methodology is described in Figure 1.

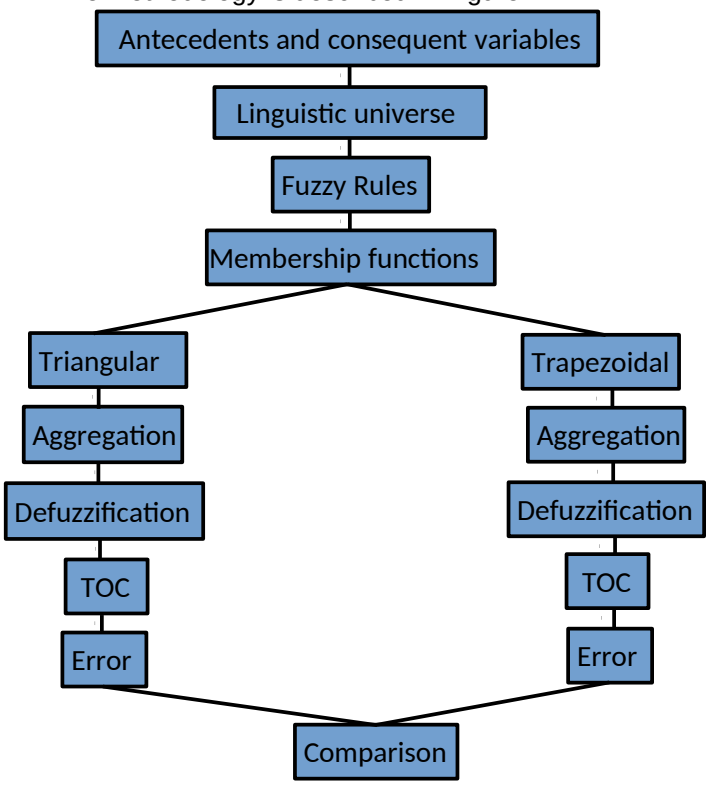
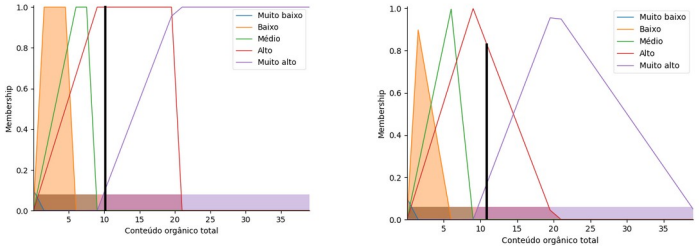


Figure 1. Methodological flowchart.

In the defuzzification stage, two membership functions (trapezoidal and triangular) were selected to

estimate the original TOC value. Defuzzification is the process in which a fuzzy set can be represented by a real number [6]. Figure 2 shows defuzzification the process for Victoria Lake.



(a) (b)

Figure 2. (a) defuzzification process using a trapezoidal membership function. (b) defuzzification process using a triangular membership function.

The error was determined by the calculation of the Loss function between the observed TOC data and the calculated TOC fuzzy data.

Results and Discussion

The tests carried out with the previously selected lake data, in the East African Rift System show that the results obtained by the fuzzy model are in agreement with the measured TOC. In Lake Victoria, calculated TOC shows values up to 11%. This value coincides with the observed TOC.

In most of the lakes studied membership function tests show a better performance for triangular function. Victoria Lakes presents an error of 0.35% for the triangular function and 1.89% for the trapezoidal function.

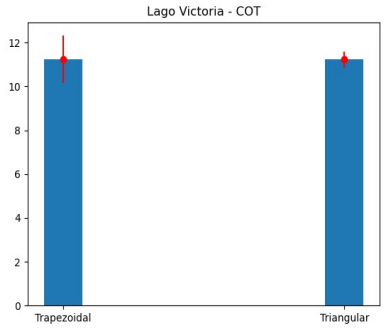


Figure 3. Predictive TOC comparison between two memberships functions in Victoria Lake.

Conclusions

The simulations held for the East African Lake Systems showed good results for TOC estimation when a lake TOC function is not known. The TOC concentration is better estimated when triangular membership functions are applied. The data indicates that the organic matter contents can be estimated considering important environmental variables such as primary productivity (maximum of 600 gC/m²/year) and dissolved oxygen, but also when geological parameters such as sedimentation rate, granulometry, and selection are considered.

Acknowledgments

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